

Software Product Description

PRODUCT NAME: VMS Volume Shadowing, Version 5.5

SPD 27.29.08

DESCRIPTION

VMS Volume Shadowing is a VMS System Integrated Product (SIP). VMS Volume Shadowing provides high data availability for disk storage devices by preventing data loss resulting from media deterioration or through controller or device failure. This prevents storage subsystem component failures from interrupting system or application operations. Volume shadowing is sometimes referred to as disk mirroring.

Volume shadowing maintains multiple redundant copies of data on a collection of disks called a shadow set. Shadow sets consist of one, two, or three compatible disk volumes that are referred to as shadow set members. This duplication of data provides enhanced data availability; when data is recorded on multiple disk volumes it remains accessible when one volume is unavailable. Disk read and write operations continue transparently with the remaining members of the shadow set.

Because a shadow set is made up of multiple disks containing the same data, the VMS Volume Shadowing software can read from any member of the shadow set. The VMS Volume Shadowing software determines which disk to read from, for each read operation, using an algorithm that maximizes performance. VMS Volume Shadowing ensures that disk write operations are duplicated on all shadow set members. For maximum performance, VMS Volume Shadowing ensures that shadow set write operations are issued to shadow set members in parallel.

If some data on a shadow set member becomes unreadable, the shadowing software can read the data from another member. Additionally, with Digital Storage Architecture disks, the member with unreadable data can be repaired by rewriting the data to good, replacement areas provided on each disk.

VMS system disks and any Files-11 On-Disk Structure 2 (ODS2) data disks can be volume shadowed.

For the purposes of this document, the term CPU is used to refer to a single VAX computer, containing one or more processors. A CPU can be a standalone system or a member of a VAXcluster system.

VMS Volume Shadowing provides two modes of operation:

- **VMS Volume Shadowing Phase I**

This is the original implementation of the VAX Volume Shadowing product. VMS Volume Shadowing Phase I performs shadowing on VMS systems using Hierarchical Storage Controllers (HSC). HSC subsystems provide control for RA-series Digital Storage Architecture (DSA) disks. This mode of shadowing is limited to disks connected to HSCs, either in single CPU or VAXcluster systems. Since shadow sets are manipulated by the HSC under the control of VMS Volume Shadowing, all members of the set must be directly connected to the same HSC.

- **VMS Volume Shadowing Phase II**

VMS Volume Shadowing Phase II is the second generation implementation of volume shadowing for VMS systems. Phase II provides support for all Phase I configurations and, in addition, supports many more disk controllers and devices in a wider range of configurations.

Phase II supports VAXcluster-wide shadowing of all Digital Small Computer Storage Interconnect (SCSI) and Digital Storage Architecture (DSA) disk storage systems. Phase II is not limited to HSC controlled disks; it supports all DSA and Digital SCSI controllers that are locally connected to a CPU and RF-series controllers/disks connected to the Digital Storage System Interconnect (DSSI). Phase II volume shadowing also supports VMS MSCP-served DSA and Digital SCSI disks located within any supported VAXcluster configuration.

It is possible to use both phases of shadowing on the same CPU or VAXcluster system at the same time. Any given shadow set must be either Phase I or Phase II; a shadow set cannot be a mixture of the two modes of shadowing.

A VMS system parameter is used to enable either, or both, modes of shadowing at system initialization. The generic device name of a Phase I shadow set is DUS or DJS, for a Phase II shadow set the generic name is

DSA. When a shadow set is mounted the VMS Mount utility uses this variation to identify which Phase of volume shadowing is required.

Characteristics

Configuration Overview:

VMS Volume Shadowing requires a minimum of one CPU, a disk controller, and a disk unit that is either DSA or SCSI compliant. Although only one disk is required, there must be two or more disks in a shadow set in order to maintain multiple copies of the same data. This provides protection against failure or deterioration of a single volume.

Using two controllers provides a further guarantee of data availability in the event of a single controller failure. VAXcluster systems can be configured with multiple CPUs, interconnects, controllers, and disks; the resulting configurations are able to provide extremely high data availability.

Shadow Set Membership:

A shadow set can have one, two, or three members. The ability to have a shadow set with only a single member allows a two-member shadow set to continue operation after the failure of one member.

Shadow set members can be added to or removed from the shadow set at any time, without affecting system or user operation.

A disk can be removed from the shadow set by operator command, or automatically by the shadowing software. An inoperative disk is removed from the shadow set automatically; no operator intervention is required.

A disk is only added to a shadow set on explicit operator command. The shadowing software ensures that the newly added shadow set member is made identical to the other member(s) by means of a copy operation. Full read and write access to the shadow set continues while the copy operation is in progress.

Transparency to the End User:

To users and application programs, VMS Volume Shadowing transparently combines the physical members of a given shadow set into a single virtual disk. The shadow set virtual disk acts as a single disk; no user or application program modifications are necessary to have write data propagated to all of the members of a shadow set. VMS Volume Shadowing software propagates the data to all shadow set members automatically. Similarly, user and application read operations to the virtual disk are transparently routed to the optimal physical shadow set member.

VMS Volume Shadowing is invisible to application programs and users. All commands and program language features that address data on non-shadowed disks can be used to address data on shadowed disks with no changes.

Configuration Limits

Phase I supports a maximum of 16 shadow set members per HSC or HSC pair (for dual-pathed disks).

Phase I supports a maximum of 8 shadow sets per HSC or HSC pair (for dual-pathed disks).

Phase II supports a maximum of 75 shadow sets in a standalone or VAXcluster system. This limit is independent of controller and device type.

A system that uses Phase I and Phase II shadowing must observe these limits respectively.

Configuration Restrictions

Configurations using Phase I shadowing must observe the following restrictions:

- If a CPU is to access any Phase I shadow sets directly, the CPU must have a direct CI path to all HSCs that contain the Phase I shadow sets (be connected to the same Star Coupler).
- A CI-connected CPU that is directly accessing a Phase I shadow set on an HSC cannot access a Phase I shadow set that is being VMS MSCP served by another VAXcluster member. A CPU must access all its Phase I shadow sets either locally or via a served path. It cannot do both.
- CPUs accessing Phase I shadow sets via an MSCP-served path (over the CI or a Local Area Network) cannot add or remove members of the shadow set, they have data access only.
- All members of a shadow set must be connected to the same HSC. If the members are dual pathed between two HSCs, they must be dual pathed between the same pair of HSCs, and both HSCs must be connected to the same Star Coupler.
- Phase I shadow sets cannot include disk drives that are being cached by the HSC60 or HSC90 Cache option. HSC caching is disabled for disk units that are mounted into Phase I shadow sets.
- Phase I shadow sets cannot be created using ESE20 enhanced performance solid state disk drives.

Phase II shadow sets are not subject to any of the above restrictions.

All members of a given shadow set must be of the same disk type and have identical geometry (for example, all RA90 disks or all RF71 disks).

Shadow set members cannot have hardware write protection enabled. Hardware write protection stops volume shadowing software from maintaining identical volumes.

VMS Volume Shadowing does not support shadow sets mounted with the Foreign attribute.

Phase II provides support for all Digital SCSI disks and controllers. It is also possible to use Phase II shadowing with non-Digital SCSI disks that have READL (read long) and WRITEL (write long) commands implemented and use the VMS SCSI disk driver (DKDRIVER). Functionality is restricted when SCSI disks that do not support READL and WRITEL are shadowed; disk bad block errors encountered when using these disks can cause members to be removed from the shadow set. The VMS Mount utility will, by default, not permit SCSI disks that do not implement READL and WRITEL to become members of a shadow set. This behavior can be overridden with the No_Forced_Error Mount qualifier.

HARDWARE REQUIREMENTS — Phase I

At least one HSC-series controller is required. Phase I supports all HSC controllers, and all RA-series disk devices that can be attached to them, as defined in the VMS Operating System Software Product Description (SPD 25.01.xx).

HARDWARE REQUIREMENTS — Phase II

VMS Volume Shadowing Phase II does not depend on specific hardware in order to operate. All shadowing functions can be performed on any supported CPU. Members of a shadow set can be located on a single CPU or anywhere in a VAXcluster system. There are no restrictions on the location of shadow set members beyond the valid disk configurations defined in the VMS Operating System Software Product Description (SPD 25.01.xx) and the VAXcluster Software Product Description (SPD 29.78.xx).

Disk Controller Support:

Phase II supports all HSC controllers, DSSI adapters, and local DSA or Digital SCSI controllers, as defined in the VMS Operating System Software Product Description (SPD 25.01.xx).

Disk Drive Support:

Phase II supports all ESE, RA, RF, RD, and RZ-series disk devices, as defined in the VMS Operating System Software Product Description (SPD 25.01.xx).

Notes:

- Phase II shadow sets can mix HSC disks that are cached by the HSC60 or HSC90 Cache option with disks that are not cached.
- KDM70 controllers must be at microcode revision 2.5, at a minimum.
- The UDA50 UNIBUS controller does not support the ESE-series devices.
- The integrated disk controller provided in MicroVAX 2000 systems is not DSA compliant, and is not supported by VMS Volume Shadowing.
- RD-series disk drives can only be shadowed when connected to RQDX-series disk controllers.

VAXcluster Environment

VMS Volume Shadowing is fully supported in a VAXcluster when installed on any valid and licensed configuration.

A VAXcluster Quorum Disk cannot be shadowed.

For additional information, refer to the VAXcluster Software Product Description (SPD 29.78.xx).

SOFTWARE REQUIREMENTS

VMS Volume Shadowing, Version 5.5 is a VMS System Integrated Product that requires VMS, Version 5.5.

For additional information, refer to the VMS Operating System Software Product Description (SPD 25.01.xx).

HSC Software, Version 6.0, at a minimum, is required for the HSC40, HSC60, HSC70, and HSC90. HSC Software, Version 4.1, at a minimum, is required for the HSC50.

OPTIONAL SOFTWARE

None

GROWTH CONSIDERATIONS

The minimum hardware/software requirements for any future version of this product may be different from the requirements for the current version.

ORDERING INFORMATION

Software Licenses: QL-AB2A*-**

Software Documentation: QA-AB2AA-GZ

Software Product Services: QT-AB2A*-**

- * Denotes variant fields. For additional information on available licenses, services, and media, refer to the appropriate price book.

The above information is valid at time of release. Please contact your local Digital office for the most up-to-date information.

SOFTWARE LICENSING

This software is furnished under the licensing provisions of Digital Equipment Corporation's Standard Terms and Conditions. For more information about Digital's licensing terms and policies, contact your local Digital office.

License Management Facility Support:

VMS Volume Shadowing supports the VMS License Management Facility (LMF).

License units for this product are allocated on an Unlimited System Use basis.

Every CPU in a VAXcluster that mounts a Phase II shadow set must have a VMS Volume Shadowing License installed. VAXcluster members that only mount VMS MSCP-served Phase I shadow sets do not require a VMS Volume Shadowing License due to the restricted functionality available with this mode of operation.

For more information about the License Management Facility, refer to the VMS Operating System Software Product Description (SPD 25.01.xx) or the *License Management Utility Manual* of the VMS Operating System documentation set.

For more information about Digital's licensing terms and policies, contact your local Digital office.

SOFTWARE PRODUCT SERVICES

A variety of service options are available from Digital. For more information, contact your local Digital office.

SOFTWARE WARRANTY

Warranty for this software product is provided by Digital with the purchase of a license for the product as defined in the Software Warranty Addendum of this SPD.

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Software Product Description

PRODUCT NAME: VMS Operating System, Version 5.5

SPD 25.01.35

DESCRIPTION*

VMS is a general-purpose multiuser operating system that supports VAX, MicroVAX, VAXstation, and VAXserver series computers in both development and production environments. VMS can be tuned to perform well in a wide variety of applications, including compute-intensive, Input/Output (I/O)-intensive, real-time, and combinations of those and other environments. (Actual performance depends on the type of VAX computer, available physical memory, and the number and type of disk and tape drives on the system.)

VMS has well-integrated networking, distributed computing, multiprocessing, and windowing capabilities. VMS contains extensive features that promote ease-of-use, improve the productivity of programmers, and facilitate system management.

VMS also supports a large number of industry standards, facilitating application portability and interoperability.

User Environment

Users can access VMS by using the English-like Digital Command Language (DCL), the command language for VMS that is supplied with the system. DCL commands take the form of a command name followed by parameters and qualifiers. DCL commands provide information about the system, initiate system utilities, and initiate user programs. VMS prompts users to enter required DCL parameters, making it easy for novice users to use.

Users can enter DCL commands at a terminal or include them in command procedures and can run command procedures interactively or submit them to a batch queue for deferred execution.

* "Licensee agrees to only execute Display PostScript® on those Digital computer systems identified as licensed systems in this Software Product Description, and that in any event licensee agrees not to make use of the software directly or indirectly, to print bitmap images with print resolutions greater than 150 DPI, or to generate fonts or typefaces for use other than with the Digital licensed system." (Terms and Conditions for Display PostScript can be found in Appendix C of this Software Product Description (SPD).)

Information on DCL and VMS Utilities is available through online Help. Online Help includes summary operational information on all aspects of system operation.

A number of tools and utilities are integrated into the VMS Operating System. This section briefly describes some of these tools and utilities.

Text processing — The Extensible VAX Editor (EVE), one of several text editors supplied by Digital, allows users to insert, change, and delete text quickly. Written in the VAX Text Processing Utility Language (VAXTPU), EVE is a full-screen editor that allows users to scroll through text on a terminal screen. EVE provides an EDT-style keypad, allowing users of EDT to transition to EVE easily.

Mail facility — The Mail facility allows users to send messages to any other user on the system. Multinode operation is available if DECnet-VAX is installed and licensed on each participating node.

Command-level programming — Command-level programming allows users to create special files called command procedures that contain a series of DCL commands. When users start a command procedure, the system processes the commands in the command procedure. Users can also use special DCL commands to assign symbolic names, evaluate numerical and logical expressions, accept parameters, communicate interactively with the user invoking the command procedure, perform conditional (IF-THEN-ELSE) and branching (GOTO) logic, and handle error conditions.

User Environment Tailoring — Users can customize the computing environment with user login command procedures, shorthand commands, binding of commands to function keys, and command recall and editing.

Program Development Environment

VMS provides a comprehensive set of tools for developing programs including editors (for editing source programs), a linker, a librarian, and a symbolic debugger. The assembly-level VAX MACRO language is supplied with VMS.

The VMS Run-Time Library provides string manipulation, I/O routines, I/O conversion, terminal independent screen handling, date and time formatting routines, common mathematical functions, signaling and condition handling, and other general purpose functions. These routines can be called from programs written in VAX MACRO or from VAX Ada, VAX BASIC, VAX BLISS-32 Implementation Language, VAX C, VAX COBOL, VAX DIBOL, VAX FORTRAN, VAX Pascal, VAX PL/I, and VAX SCAN.

Major VMS languages (including those listed above) adhere to the VAX common calling standard, meaning that routines written in any of these languages can directly call routines written in any other language. Development of applications using multiple languages is simple and straightforward.

All routines in the Run-Time Library follow the VMS calling standard and condition handling conventions and most are contained within a shareable image.

At a lower level, programs can call system services directly for security, event flag, asynchronous system trap, logical name, record and file I/O, process control, timer, time conversion, condition handling, lock management, and memory management services. Again, system services use the VMS calling standard and condition handling conventions.

VMS supports execution of non-privileged images created on earlier versions of VMS. Recompiling and re-linking are typically not required.

Some tools available to the VMS programmer are:

Librarian utility — The Librarian utility permits efficient storage of object modules, macros, Help text, or any general record-oriented information in central, easily accessible files. Object module libraries are searched by the linker when the linker finds a reference it cannot resolve in one of its input files. Macro libraries are searched by the assembler when the assembler finds a macro that is not defined in the input file.

Debugger — The debugger allows users to trace program execution as well as display and modify register contents using the same symbols that are in the source code.

RMS file utilities — RMS file utilities allow users to analyze the internal structure of an RMS file and to determine the most appropriate set of parameters for an RMS file. They can also be used to create, efficiently load, and reclaim space in an RMS file. Refer to the *Operating System Environment* section of this Software Product Description (SPD) for more information on RMS.

File Differences utility — This utility compares the contents of two files and lists those records that do not match.

Terminal Fallback Facility (TFF) — This facility allows Digital 7-bit terminals, such as the VT100, to input and output the DEC Multinational Character Set (MCS). Specific tables allow conversion for a number of different 7-bit National Replacement Character sets, such as French, German, Spanish, and Swedish, to MCS. TFF also allows character composition on terminals that do not have the compose key.

National Character Set (NCS) utility — This utility allows users to define non-ASCII string collating sequences and to define conversion functions. Conversion functions use conversion algorithms to change an input string, for example, to change lower case characters to upper case. NCS also allows RMS indexed files to be collated using user-specified collating sequences.

System Management Environment

VMS provides a variety of tools to aid the system manager in configuring and maintaining an optimal system. Some tools available for the system manager are:

Backup utility — This utility provides full volume and incremental file backup for file-structured, mounted volumes and volume sets. Individual files, selected directory structures, or all files on a volume set can be backed up and restored. Files can be selected by various dates (creation, modification, etc.). Files can be backed up to magnetic tape, magnetic disk, or WORM (Write Once Read Many) optical disk. With standalone backup, system managers can backup and restore system disks. Standalone Backup can also be used during the installation of the VMS Operating System. The Backup utility can be used to restore a saveset or list the contents of a saveset.

Analyze disk structure utility — This utility compares the structure information on a disk volume with the contents of the disk, prints the structure information, and permits changes to that information. It also can be used to repair errors that are detected in the file structure of disks.

Monitor utility — This utility permits the system manager to monitor different classes of system-wide performance data including process activity, I/O activity, memory management activity, vector processing activity, and two-phase commit transaction activity at specified intervals. The data may be displayed as it is gathered or saved in a file for later use.

License Management Facility (LMF) — This facility allows the system manager to easily determine which software products are licensed on a standalone VAX and on each of the VAX systems in a VAXcluster System. It allows the system manager to select which subset of systems or users in a VAXcluster may use the software products. LMF also provides an audit trail that allows

the system manager to track license changes that occur within a VAXcluster system. Refer to the *VAXcluster Support* section for more information on VAXcluster Systems.

VMS System Management (SYSMAN) utility — This utility allows the system manager to define a system management environment so that operations performed from the local VAX system can be executed on all other VAX systems in the defined environment. The environment may include VAX systems in a DECnet-VAX network or in a VAXcluster System.

Operations — VMS enables varying levels of privilege to be assigned to different operators. In addition, system generated messages can be routed to different terminals based on their interest to the console operators, tape librarians, security administrators, and system managers. Operators can use the VMS Help facility to get an online description of VMS Error Messages.

Security and Control — VMS provides privilege, protection, and quota mechanisms to control user access to system-controlled structures in physical memory, to system-structured files and volumes, and to certain devices.

User account information is maintained by the system manager in the User Authorization File (UAF). When creating user accounts with the Authorize utility, the system manager assigns the privileges and quotas associated with each user account. The system manager also assigns a unique user name, password, and user identification code (UIC) to each account. Optionally, additional identifiers can be assigned to each account, permitting users to belong to multiple overlapping groups or projects. Account use may be limited by time of day, day of week, and type of access, such as local, remote, or batch.

To log in and gain access to the system, the user must supply the user name and password. The password is encoded and does not appear on terminal displays. Users can change their password voluntarily, or the system manager can selectively enforce how frequently passwords change, password length, and generation of random alphabetic passwords.

Additionally, VMS provides several password filters that screen all user password changes against a dictionary of common passwords. This prevents users from reusing passwords that they have used within the last year. In addition to these built-in filters, a site can install their own filter to screen passwords against a site-specific password policy.

The system password hash algorithm can also be replaced with a private algorithm for those sites that have

contractual agreements to use specific password encryption algorithms. This feature can be enabled on a per-user, per-password basis.

Login security includes breakin detection, which allows terminals to be disabled when password guessing is detected. When a user logs in, the system displays a message stating when the last login for the account occurred and if there have been failed attempts to log in since the last successful login.

A UIC consists of two fields, the unique user field and a group field. Every file, device, queue, or other system object is labeled with the UIC of its owner (normally the user who created the object).

Files, devices, queues, and other system objects are assigned a protection mask that allows read, execute, write, and delete access to be selectively granted to the object's owner and group, to privileged system users, and to all other users. In addition, files, devices, queues, and some other system objects can be protected with access control lists to allow access to be selectively granted or denied to a list of individual users, groups, or identifiers.

Scavenge protection can be enabled selectively in the form of file high-water marking, erase on allocate, and erase on delete, to ensure that file contents cannot be read after a file has been deleted.

Security alarms are provided to allow selective auditing of security related events, including:

- Login and logout
- Login failures and breakin attempts
- Authorization changes
- File access, selectable by use of privilege, type of access, and by individual file

Note: No system can provide complete security and Digital cannot guarantee system security. However, Digital continually strives to enhance the security capabilities of its products. Customers are strongly advised to follow industry-recognized security practices.

INSTALLATION

VMS is distributed as binary kits on tape and compact disc. Procedures for setting up the system disk from a kit and for preparing the system for day-to-day operations are easy and straightforward. The procedures are described in the *VMS Upgrade and Installation Manual* and Cover Letter. Computer-specific information is contained in the upgrade and installation supplements for each family of VAX computers.

The VMS AUTOGEN command procedure automatically sets a number of system parameters by detecting devices installed in a configuration. A feedback option can be used to generate a report of recommended parameter settings for system tuning.

VMS/INSTAL

VMS includes a facility to automate operating system software updates, as well as to handle the installation of optional Digital-supplied software products.

Tailoring Facility

Tailoring lets the system manager remove groups of VMS files from the system disk or add groups of VMS files that were formerly removed. The VMSTAILOR program supplies step-by-step instructions. The DECW\$TAILOR program is used to add or remove groups of DECwindows files from the system disk.

Due to space constraints, there is no guarantee that layered products can be installed if user files reside on the system disk.

Application programs will execute as long as the layered products or optional software products do not depend on optional software run-time components that are not supported in the tailored environment. Refer to the product's System Support Addendum (SSA) for the optional products supported in the tailored environment.

Batch/Print Facility

VMS provides an extensive batch/print facility that allows the creation of queues and the setup of spooled devices in order to process non-interactive workloads in parallel with timesharing or real-time jobs.

In the VMS Operating System, batch and print operations support two types of queues: generic queues and execution queues. A generic queue is an intermediate queue that holds a job until an appropriate execution queue becomes available to initiate the job. An execution queue is a queue through which the job (either print or batch) is actually processed or executed.

The system queues batch jobs for execution. The system manager can regulate the number of queues and the number of streams per queue (that is, the number of batch jobs in the queue that can execute concurrently).

Both generic and execution batch queues can have different attributes, such as the maximum CPU time permitted, working set size, and priority. Facilities are provided for starting and stopping queues, and for starting and stopping jobs in a queue. Because multiple execution queues can be associated with a generic queue, VMS enables load balancing across available CPUs in a VAXcluster system, increasing overall system throughput.

Print queues, both generic and execution, together with queue management facilities, provide versatile print capabilities, including support of ANSI and PostScript® file printing.

Sites requiring sophisticated batch job dependency checking and job restart capabilities should refer to the DECscheduler for VMS Software Product Description (SPD 32.19.xx).

Accounting

For accounting purposes, VMS keeps records of the use of system resources. These statistics include processor and memory utilization, I/O counts, print symbiont line counts, image activation counts, and process termination records. VMS Accounting allows various reports to be generated using this data.

Autoconfigure/Autogen

VMS provides utilities to automatically configure the available devices into the system tables and to set system operational parameters based on the detected peripheral and memory configuration. There is no need for a traditional "system generation" process when the hardware configuration is expanded or otherwise modified.

Operating System Environment

Process and Scheduling

The basic unit of execution in VMS is the process. A process consists of individual address space and registers known as "context," and code called an "executable image." The context identifies the process and describes its current state. Executable images consist of system programs and user programs that have been compiled and linked.

The maximum number of concurrent processes is 8,192 per VAX system.

Processes receive processor time to execute their images based on the priority of the process. Thirty-two priorities are recognized: priorities 0 to 15 are for time-sharing processes and applications that are not time critical (four is the typical default for time-sharing processes), and priorities 16 to 31 are for real-time processes.

Each time an event such as an I/O interrupt occurs, the system first services the event and then passes control to the highest priority process ready to execute. The system automatically adjusts priorities of processes whose base priority is in the range of 0 to 15 to favor I/O-bound and interactive processes, but the system will not adjust the priority of a process in the range of 16 to 31.

Real-time processes can be assigned higher priorities to ensure that they receive processor time whenever they are ready to execute. Real-time processes are scheduled pre-emptively; that is, if a real-time process is ready to execute, it is given the processor immediately, unless a real-time process with a higher priority is ready to execute.

VMS uses paging and swapping mechanisms to provide sufficient virtual memory for multiple concurrently executing processes. Also, paging and swapping is provided for processes whose memory requirements exceed available physical memory. The maximum working set size is 200,000 pages of memory.

Programmers can exercise control over memory management from within an image. An image executing in a real-time process, for example, can inhibit paging or swapping of critical code and data.

Peripheral devices can be managed by the system or allocated by individual processes. At least one disk must be a system disk. Other disks can be designated as data disks for the general use of all users logging into the system or for a specific group of users. The system controls interactive terminals and one or more printers.

Vector Processing

A single data item, having one value, is known as a scalar value. A group of related scalar values, or elements, all of the same data type, is known as a vector.

An extension to the VAX architecture defines an optional design for integrated vector processing that has been adopted by several VAX systems. The VAX vector architecture includes 16 64-bit vector registers (V0 through V15), each containing 64 elements; vector control registers; vector function units; and a set of vector instructions. VAX vector instructions transfer data between the vector registers and memory, perform integer and floating-point arithmetic, and execute processor control functions.

A more detailed description of the VAX vector architecture, vector registers, and vector instructions appears in the *VAX MACRO and Instruction Set Reference Manual*.

The VMS Operating System provides fully-shared, multi-programming support for VAX vector processing systems. By default, VMS loads vector support code when initializing vector-present systems, but does not load it when initializing vector-absent systems. A system manager can control this behavior by using the SYSGEN parameter VECTOR_PROC, as described in the VMS documentation.

The presence of vector support code in a system has little affect on processes running in a scalar-only system, or scalar processes running in a vector-present system. If many processes must simultaneously compete for vector processor resources in a system, the system manager can maintain good performance by adjusting system resources and process quotas as indicated in the VMS documentation.

The VMS Operating System makes the services of the vector processor available to system users by means of a software abstract known as a capability. A system manager can restrict the use of the vector processor to users holding a particular identifier by associating an access control list (ACL) entry with the CAPABILITY object VECTOR.

The VAX Vector Instruction Emulation Facility (VVIEF) is a standard feature of the VMS Operating System that allows vectorized applications to be written and debugged in a VAX system in which vector processors are not available. VVIEF emulates the VAX vector processing environment, including the non-privileged VAX vector instructions and the VMS vector system services, as described in the VMS documentation. Use of VVIEF is restricted to user mode code.

DECdtm Services

The DECdtm services embedded in the VMS Operating System support fully distributed databases using a "two phase commit" protocol. The DECdtm services provide the technology and features for distributed processing, ensuring both transaction and database integrity across multiple resource managers. Updates to distributed databases occur as a single "all or nothing" unit of work, regardless of where the data physically resides. This ensures consistency of distributed data.

DECdtm services allow applications to define "global transactions" that may include calls to any of a number of Digital data management products. Regardless of the mix of data management products used, the global transaction will either commit or abort. VMS is unique in providing transaction processing functionality as base operating system services.

DECdtm Features

- Embedded VMS system services support the DECtp architecture, providing features and the technology for distributed transaction processing.
- DECdtm allows multiple disjoint resources to be updated atomically. These resources can be either physically-disjointed (for example, on different CPUs) or logically-disjointed (for example, in different databases on the same CPU).

- DECdtm encourages robust application development. Applications can be written to ensure that data is never in an inconsistent state, even in the event of system failures.
- As a VMS service, DECdtm can be called using any Digital TP monitor (ACMS or DECintact) or database product (DBMS, RDB, RMS). This is useful for applications using several database products.

Interprocess Communication

VMS provides a number of facilities for applications that consist of multiple cooperating processes:

- Mailboxes are virtual devices that allow processes to communicate with queued messages.
- Shared memory sections on a single processor or a symmetrical multiprocessing (SMP) system permit multiple processes to access shared address space concurrently.
- Common event flags provide simple synchronization.
- The lock manager provides a more comprehensive enqueue/dequeue facility with multi-level locks, values, and ASTs (Asynchronous System Traps).

Symmetric Multiprocessing

VMS provides symmetric multiprocessing (SMP) support for multiprocessing VAX systems. SMP is a form of tightly coupled multiprocessing in which all processors perform operations simultaneously. The processors can perform operations in all VAX access modes (user, supervisor, executive, and kernel).

VMS SMP configurations consist of multiple central processing units executing code from a single shared memory address space. Users and processes share a single copy of VMS. SMP also provides simultaneous shared access to common data in global sections to all processors. VMS SMP dynamically balances the execution of all processes across all available processors based on process priority.

SMP support is an integral part of VMS and is provided transparently to the user. Because an SMP system is a single system entity, it is configured into a network and VAXcluster systems as a single node.

VAXcluster Support

VAXcluster Software is a VMS System Integrated Product (SIP) that is separately licensed. It provides a highly integrated VMS computing environment distributed over multiple VAX, VAX Workstation, and MicroVAX CPUs. This environment is called a VAXcluster system and may contain up to 96 VAX CPUs.

VAXcluster CPUs communicate using any combination of four interconnects; CI, DSSI, Ethernet, and FDDI. VAXcluster systems that include a CI may optionally be configured with HSC-series intelligent storage controllers.

Applications running on one or more CPUs in a VAXcluster system access shared resources in a coordinated manner. VAXcluster Software components synchronize access to shared resources, preventing multiple processes on any CPU in the VAXcluster from interfering with each other when updating data. This coordination ensures data integrity during multiple concurrent update transactions. Application programs can specify the level of VAXcluster-wide file sharing that is required; access is then coordinated by the VMS Extended QIO Processor (XQP) and Record Management Services (RMS).

The VMS queue manager controls VAXcluster-wide batch and print queues, which can be accessed by any VAXcluster CPU. Batch jobs submitted to VAXcluster-wide queues are routed to any available CPU so that the batch load is shared.

Two or more VAX computers connected to the same Computer Interconnect (CI) or Digital Storage Systems Interconnect (DSSI) must run VAXcluster software and be part of the same VAXcluster system.

Refer to the VAXcluster Software Software Product Description (SPD 29.78.xx) for more information.

Networking Facilities

VMS provides device drivers for all Digital Ethernet adapters listed in the *Ethernet Options* section of this SPD. Application programmers can use the QIO system service to communicate with other systems connected via the Ethernet using either Ethernet or IEEE 802.3 packet format. Simultaneous use of Digital Ethernet and IEEE 802.3 protocols are supported on any Digital Ethernet adapter.

VMS also provides device drivers for Digital asynchronous adapters that are supported by DECnet-VAX. Customers must order the VAX Wide Area Network Device Drivers kit (refer to SPD 29.64.xx) to obtain synchronous device drivers for Digital synchronous adapters. Not all devices are supported, and certain restrictions apply relative to line speed and line utilization. Refer to the *Hardware Charts* and *Appendix B* of this SPD, as well as the DECnet-VAX SPD (25.03.xx), for more information.

DECnet-VAX offers task-to-task communications, file management, downline system and task loading, network command terminals, and network resource sharing capabilities using the Digital Network Architecture (DNA) protocols.

DECnet-VAX Software is a System Integrated Product (SIP) that is separately licensed from the VMS Operating System. Refer to the DECnet-VAX SPD (SPD 25.03.xx) for further information on supported communications devices and software features.

Internet networking is available through the VMS/ULTRIX Connection layered product. This product provides TCP /IP networking (useful with DECwindows), Network File System (NFS), File Transfer Protocol (FTP), Remote Terminal Services (TELNET), and other features. Refer to the VMS/ULTRIX Connection SPD (SPD 25.A4.xx).

Terminal Server Products

Digital's terminal server products can be used for terminal server access to VMS. When used in a VAXcluster system environment, terminal servers automatically distribute users at login time across the available VAX systems.

VMS can also establish a connection to other devices (such as printers) attached to such terminal servers.

Reliability

The system handles hardware errors as transparently as possible while maintaining data integrity and providing sufficient information to diagnose the cause of the error. The system limits the effects of an error by first determining if the error is fatal. If the error is fatal then the process that encountered the error is aborted. If the error occurs in system context then the current VMS session is shut down. If the error is not fatal then recovery actions pertinent to the error are executed and current operation is continued.

In all cases, information relevant to the error is collected and put in the error log file for later analysis. Hardware errors include the following categories:

- Processor errors (these include processor soft errors, processor hard errors, processor machine checks, adapter errors).
- Memory errors are hardware errors that are handled in a slightly different manner. The system examines memory at startup time and does not use any pages found to be bad. During system operation, the hardware transparently corrects all single-bit memory errors for those systems with ECC memory. An unrecoverable error causes the memory page on which the error occurred to be added to the bad page list. If the page has not been modified, system operation continues with a new copy of the page.

Other failures include:

- Operating system errors (system-detected inconsistencies or architectural errors in system context)
- User errors

- I/O errors

The system logs all processor errors, all operating system errors detected through internal consistency checks, all double-bit memory errors (and a summary of corrected single-bit errors), and all I/O errors. (Double-bit errors are detected only on those VAX and MicroVAX systems with ECC memory.)

If the system is shut down because of an unrecoverable hardware or software error, a dump of physical memory is written. The dump includes the contents of the processor registers. The VMS System Dump Analyzer utility is provided for analyzing memory dumps.

Power Failures

If power fails, the system shuts down automatically. When power is restored, the system restarts automatically and resumes processing at the point of interruption if the system has a time-of-day clock and a memory battery backup unit, if the contents of memory are still valid, and if the system is set to permit automatic rebooting.

The system restarts devices and communications lines. All I/O operations in progress, including magnetic tape I/O operations, are restarted. On request, programs can be notified of power restoration. An optional battery-operated hardware clock resets the date and time of day when the system restarts. If the system does not have a battery backup unit, or if the memory contents are not valid on power restoration, the system will reboot automatically if the system is set to permit automatic rebooting.

If, for any reason, the system disk does not come back on line after a power failure within a specific time after the CPU regains power, the system shuts down.

Test Package and Diagnostics

VMS includes a User Environment Test Package (UETP) that verifies that the VMS Operating System is properly installed and ready for use on the customer's systems.

Diagnostics can be run on individual devices during normal system operation. Certain critical components can operate in degraded mode. For example, the memory cache can be disabled. The system places a component in degraded mode when errors pass a threshold level.

Input/Output

The QIO system service provides a direct interface to the operating system's I/O routines. These services are available from within most VAX programming languages and can be used to perform low-level I/O operations efficiently with a minimal amount of system overhead for time-critical applications.

Device drivers execute I/O instructions to transfer data to and from the device and to communicate directly with an I/O device. Each type of I/O device requires its own driver. Digital supplies drivers for all devices supported by the VMS Operating System and provides QIO system service routines to access the special device dependent features available in many of these devices. Users with special needs or non-VMS supported devices can write their own device drivers. The *VMS Device Support Manual* and the *VMS Device Support Reference Manual* in the VMS Extended Documentation set describe how to write device drivers.

The VMS Operating System supports a variety of disk and tape peripheral devices, as well as terminals, networks, mailboxes (virtual devices for interprocess communication), and more general I/O devices. These I/O devices include line printers, card readers, and general purpose data acquisition devices such as the DRB32.

VMS Record Management Services (VMS RMS)

VMS RMS is a set of I/O services that help application programs to process and manage files and records. Although it is primarily intended to provide a comprehensive software interface to mass storage devices, VMS RMS also supports device-independent access to unit-record devices.

VMS RMS supports sequential, relative, and indexed file organizations in fixed-length and variable-length record formats. VMS RMS also supports byte stream formats for sequential file organization. VMS RMS record access modes provide access to records in four ways: sequentially, directly by key value, directly by relative record number, and directly by record file address. VMS RMS also supports block I/O operations for various performance-critical applications that may require user-defined file organizations and record formats.

VMS RMS promotes safe and efficient file sharing by providing multiple file access modes, automatic record locking where applicable, and optional buffer sharing by multiple processes.

VMS RMS utilities aid file creation and record maintenance. These utilities convert files from one organization and format to another, restructure indexed files for storage and access efficiency, and reclaim data structures within indexed files. The utilities also generate appropriate reports.

For systems that have DECnet installed, VMS RMS provides a subset of file and record management services to remote network nodes. Network remote file operations are generally transparent to user programs.

DCL commands such as EDIT, CREATE, COPY, TYPE, and PRINT allow manipulation of RMS files and records within RMS files at the DCL command level.

VAX RMS Journaling

VAX RMS Journaling is a tool that maintains the data integrity of RMS files in the face of a number of failure scenarios. It helps to protect RMS file data from becoming lost or inconsistent. RMS Journaling is a System Integrated Product (SIP) that is separately licensed. Refer to the *VAX RMS Journaling SPD (SPD 27.58.xx)* for more information.

Disk and Tape Volumes

Disk volumes can be organized into volume sets. Volume sets can contain a mix of disk device types and can be extended by adding volumes. Within a volume set, files of any organization type can span multiple volumes. Files can be allocated to the set as a whole (the default) or to specific volumes within the set. Optionally, portions of indexed files can be allocated to specific areas of a single disk volume or to specific volumes in a volume set.

Disk quotas can be placed to control the amount of space individual users can allocate. Quota assignment is made by User Identification Code and can be controlled for each volume set in the system (or for each individual volume if the volume is not part of a set).

Disk structure information can be cached in memory to reduce the I/O overhead required for file management services. Although not required to do so, users can preallocate space and control automatic allocation. For example, a file can be extended by a given number of blocks, contiguously or noncontiguously, for optimal file system performance in specific cases.

The system applies software validity checks and checksums to critical disk structure information. If a volume is improperly dismounted because of user error or system failure, the system automatically rebuilds the volume's structure information the next time the volume is mounted. The system detects bad blocks dynamically and prevents their reuse once the files to which the blocks were allocated are deleted. On Digital Storage Architecture (DSA) disks, the disk controller dynamically detects and replaces bad blocks automatically.

The system provides eight levels of named directories and subdirectories whose contents are alphabetically ordered. Device and file specifications follow Digital conventions. Logical names can be used to abbreviate the specifications and to make application programs device

and file-name independent. A logical name can be assigned to an entire specification, to a portion of a specification, or to another logical name.

VMS supports multivolume magnetic tape files with transparent volume switching. Access positioning is done either by filename or by relative file position.

VMS Volume Shadowing

Digital provides the VMS Volume Shadowing product for performing disk shadowing operations.

VMS Volume Shadowing is a VMS System Integrated Product (SIP) that is separately licensed. VMS Volume Shadowing provides high data availability for disk storage devices by ensuring against data loss resulting from media deterioration or through controller or device failure. This prevents storage subsystem component failures from interrupting system or application operation.

The system disk and Files—11 On-Disk Structure 2 (ODS2) data disks can be volume shadowed.

The VMS Volume Shadowing product supports shadowing of all MSCP-compliant DSA disks and all Digital SCSI disks. All disks in a single shadow set must have the same physical geometry and can be located on a single system or anywhere in a VAXcluster system. Disks can be configured on any MSCP or Digital SCSI compliant controller; this includes HSC-series controllers, local controllers, DSSI Integrated Storage Elements, and VMS MSCP Served DSA devices. Nonlocal disks can be accessed using any of the supported VAXcluster interconnects (CI, DSSI, Ethernet, FDDI, and mixed).

VMS Volume Shadowing provides fault tolerance resulting from disk media errors or controller errors across the full range of VAX processors and configurations. Shadow set member units can be located on different controllers and VMS MSCP servers, providing configuration flexibility and a high degree of data availability.

Refer to the VAX Volume Shadowing SPD (SPD 27.29.xx) for more information.

VMS DECwindows Environment

Integral to VMS is support for the VMS DECwindows desktop environment. VMS DECwindows is based on the X User Interface (XUI) and is delivered as a component of the VMS Operating System. Additionally, Digital offers a new separately orderable layered product called VMS DECwindows Motif™. VMS DECwindows Motif provides support for both OSF/Motif™, an open standard that is the new default user interface, and the X User Interface in a single run-time and development environment. Because both Motif and XUI are based on MIT's X Window System, applications written to either toolkit continue to run regardless of which environment

the user selects. Refer to the VMS DECwindows Motif SPD (SPD 36.09.xx) for more information.

VMS DECwindows is based on MIT's specification for the X Window System, Version 11, Release 3. X Window System standards supported as part of DECwindows include the X11 network protocol, a base set of workstation fonts, the C language binding for the Xlib programming library, and the C language binding for the X toolkit library. Also featured within DECwindows for workstation users is support for Adobe's Display PostScript integrated into X11.

Support of the X11 network protocol in the client, library, and display server components provides VMS with the ability to interoperate with other X11-compliant systems in a distributed fashion.

DECwindows supports the server-client distribution inherent in the X Window System, with three VMS-provided transport interfaces — local shared memory, DECnet, and TCP/IP (using Digital's VMS/ULTRIX Connection (UCX) layered product). Users can also provide their own transport subsystems and transport interfaces.

To determine whether a separately orderable DECwindows or X application runs on or can communicate with a VMS DECwindows system, consult the application's Software Product Description.

The DECwindows desktop environment provides a graphical user interface to VMS. This user interface defines a powerful model for interacting with the VMS Operating System using a point and click metaphor. It includes a set of integrated desktop applications that demonstrate the power of this new metaphor and that provide VMS users with a base set of desktop tools.

The user environment consists of four basic components:

1. The Session Manager provides the top-level user interface to a DECwindows workstation. It performs application activation, session-wide customization, screen printing, security management, and session control. The session manager also allows users to specify the language in which DECwindows should run, provided that a VMS DECwindows language variant kit has been ordered and installed.
2. The Window Manager provides user control for managing windows.
3. FileView is a graphical interface to VMS file management that allows users to navigate through the VMS file system and perform operations on files.
4. The DECterm terminal emulator provides workstation users with a traditional character cell interface for existing VMS features and applications. It is a

ReGIS and sixel compatible VT320 terminal emulator. Programs written for VT52, VT100, VT220, or VT320-class terminals and using VMS terminal driver features operate without modification in this workstation window. DECterm also provides workstation-oriented features such as mouse-based cursor positioning, variable screen sizes, and cutting and pasting of text between terminal emulators and other DECwindows applications.

Applications

A set of integrated desktop applications is provided as a base component of the DECwindows environment. These applications establish and demonstrate the consistent DECwindows user model. They also provide significant end user capabilities.

- Bookreader — A tool for viewing the contents of books that are distributed and stored on-line
- Calculator — A basic scientific calculator
- Calendar — A personal time management system
- Cardfiler — A hierarchical information storage application similar to an online address and/or phone book
- Clock — An analog and/or digital date and time display with notification by alarm
- Compound Document viewer — Tools for reading documents containing compound text, graphics, and image data on terminals and DECwindows workstations
- DEBUG — A DECwindows user interface to the VMS DEBUGGER
- Mail — A DECwindows user interface to the VMS mail facility
- Notepad — A simple text editor
- Paint — A simple bitmap graphics editor
- Puzzle game — A game that challenges users to sort mixed up puzzle tiles
- TPU/EVE — A DECwindows user interface to the VMS TPU/EVE editor

DECwindows workstation users can display PostScript files featuring WYSIWYG (what you see is what you get) compatibility between the display and any of Digital's PostScript printers. Display PostScript ability is available within the Compound Document viewer and DECwindows Mail.

Programming Support

The VMS DECwindows environment includes an extensive set of programming libraries and tools for use by developers of new applications. These components support the development of portable applications by focusing on three broad areas:

- X Window System (X) support
- X User Interface (XUI) support
- Compound Document Architecture (CDA) support

Components from each of these areas can be used in any combination to address the needs of applications. They can also use the tools from a variety of different programming languages. All programming libraries have been provided with procedural language bindings in both the style of the VAX calling standard and the style of the MIT C language programming conventions.

Support is provided for the following languages:

VAX Ada	VAX FORTRAN
VAX BASIC	VAX MACRO
VAX BLISS-32 Implementation Language	VAX Pascal
VAX C (VAX calling standard or MIT convention)	VAX PL/I

X Window System (X) Programming Support

The X Window System compatible X programming library (Xlib) provided by the VMS DECwindows environment provides basic resource management (windows, color maps, input devices) and bitmap graphics services. It defines a mapping of the X network protocol to a procedure library.

The X toolkit programming library is also supported by the VMS DECwindows environment. It is described further under XUI Programming Support.

X User Interface (XUI) Programming Support

XUI determines the application model for Digital and third-party software tailored for the DECwindows environment. It establishes the conventions and styles that are encouraged for applications that share a DECwindows workstation. Applications use XUI components to build user interfaces that make them look and feel like integrated members of the Digital computing environment.

The XUI Style Guide, available in the VMS DECwindows Programming Kit, describes the principles, philosophy, and components used to build consistent and well-integrated DECwindows applications.

Its concepts are implemented by the XUI Toolkit. The XUI Toolkit is a superset of the X Window System X toolkit and contains four components:

- X toolkit components (known as intrinsics) for managing, modifying, and creating user interface objects (known as widgets and gadgets)
- DECwindows widgets and gadgets for implementing common user interface objects such as scroll bars, menus, and push buttons
- Utility routines that provide applications with functions for performing common tasks such as cut and paste
- Resource manager routines for loading user interface definition files and creating widgets and gadgets based on the contents of the definition files

The XUI Toolkit is used in conjunction with the DECwindows User Interface Language (UIL) compiler. The user interface definition files produced by this compiler contain the data to separate form and function in DECwindows applications and allow DECwindows toolkit widget and gadget details, such as menu item labels, to be stored separately from the toolkit and application runtime code. This capability allows application developers to prototype and modify user interface designs, separate form and function in applications, and support internationalizable products.

Enhanced X Windows Display PostScript (XDPS)

The Display PostScript system provided with VMS DECwindows extends the native X graphical programming environment for Digital DECwindows workstation users.

X Display PostScript adds the following capabilities to the basic X11 environment:

- All DECwindows fonts can be displayed at any size and rotation angle
- XDPS graphics specified in a user-defined coordinate systems are independent of monitor density
- Color or gray-scale rendition are automatically modified to take advantage of the monitor type through either direct display, color dithering, or half-toning
- DPS Display routines can be downloaded to the server and executed on command
- Sophisticated graphics primitives such as precisely-controlled Bezier curves can be displayed
- Any display can be scaled and rotated arbitrarily

Programming access to XDPS is through the Adobe Client Library. In addition, a converter called pswrap allows users to convert PostScript code into C programs that can be called from other languages.

Compound Document Architecture (CDA) Programming Support

The CDA Toolkit provides access routines that applications can use to create, read, and write files containing compound text, graphics, and imaging data. These files provide a vehicle for recording this information on disk, a medium for interchange of this data between applications, and an intermediate form from which high-resolution printable graphics data can be generated.

In addition to providing support for developing new applications to access compound documents, VMS also provides fallback support, allowing many existing utilities to read and operate on these new kinds of files.

Transport Mechanisms

VMS DECwindows supports three different user-selectable mechanisms for transport of X network protocol packets between applications and display servers.

A VMS DECwindows-specific shared memory-based transport is used when the DECwindows application and display server are located on the same workstation. This optimization provides significantly greater performance. It is the default transport under these circumstances.

DECnet is used when the DECwindows application and display server are distributed across two different machines in the network. It is the default transport under these circumstances.

TCP/IP is used when the DECwindows application and display server are distributed across two different machines in the network and the Digital-supplied VMS /ULTRIX Connection (UCX) layered product is being used to make the connection. See the SOFTWARE LICENSING section of this SPD for licensing details.

Workstation Device Support

The VMS DECwindows environment provides several software components to support displaying graphics and windowing output on and receiving keyboard and pointer driver input from VAX workstations.

Device drivers are provided to support output to monochrome and color displays and to receive input from keyboard, mouse, and tablet devices.

A display server compatible with the X Window System receives output requests from applications and translates those requests into driver commands. They also relay driver-generated input events back to the applications.

Over 400 video fonts are provided in a variety of styles and point sizes for use on 75 and 100 dot per inch (dpi) monitors. These video fonts have been designed to correspond directly to the fonts used by Digital's PostScript printers. In addition, a font compiler is provided so that customers can make their own private fonts available on their DECwindows workstations and terminals.

Multi-headed Workstation Support

A multi-headed workstation consists of one system box, one keyboard and one mouse, but more than one monitor and graphics controller. It is a single-user workstation. Multi-headed workstations provide more screen area for complex applications.

The screens on the multiple monitors are controlled by a single server. The mouse cursor can be moved freely between screens, and the keyboard can be used to generate input to windows on any screen. The server implementation handles each monitor as a separate X11 screen. This means that a single window cannot cross screen boundaries; for example, users cannot drag a window from one monitor to another. However, users can cut and paste between windows on different screens, and windows can be opened on either screen, or both, by user applications.

The Dual Monitor Adapter is a cable (model number BC09E-06) that allows two monitors to be connected at the same time to a single VAXstation 3100 system box (models 30, 38, 40, and 48). The system must include one of the 8-plane graphics options, either the GPX graphics or SPX graphics accelerator.

The system must include at least one monochrome monitor, VR150 or VR262, driven by the single-plane frame buffer that is standard on all VAXstation 3100s.

The second monitor, connected to the 8-plane graphics option, can be color, or it can be monochrome for gray scale operation. Supported color monitors are the VR160, VR290, VR297, VR299, and VRT19.

Standards

The VMS Operating System is based on the public, national, and international standards listed below. These standards are American National Standards Institute (ANSI), U.S. Federal Information Processing (FIPS), and International Standards Organization (ISO) standards. The following information may be useful in determining responsiveness to stated conformance requirements as enabled in particular commercial and/or government procurement solicitation documents.

- ANSI X3.4-1986: American Standard Code for Information Interchange
- ANSI X3.22-1973: Recorded Magnetic Tape (800 BPI, NRZI)

- ANSI X3.26-1980: Hollerith Punched Card Code
- ANSI X3.27-1987: File Structure and Labeling of Magnetic Tapes for Information Interchange
- ANSI X3.39-1986: Recorded Magnetic Tape (1600 BPI, PE)
- ANSI X3.40-1983: Unrecorded Magnetic Tape
- ANSI X3.41-1974: Code Extension Techniques for Use with 7-bit ASCII
- ANSI X3.42-1975: Representation of Numeric Values in Character Strings
- ANSI X3.54-1986: Recorded Magnetic Tape (6250 BPI, GCR)
- ANSI X3.131-1986 (SCSI I): Small Computer System Interface
- ANSI X3T9.2/89-042 (SCSI II): Small Computer System Interface as described in REV 10C
- ANSI/IEEE 802.2-1985: Logical Link Control
- ANSI/IEEE 802.3-1985: Carrier Sense Multiple Access with Collision Detection
- FIPS 1-2: Code for Information Interchange, its Representations, Subsets, and Extensions

Note: 1-2 includes ANSI X3.4-1977(86)/FIPS 15; ANSI X3.32-1973/FIPS 36; ANSI X3.41-1974/FIPS 35; and FIPS 7

- FIPS 2-1/ANSI 3.6-1965: Perforated Tape Code for Information Interchange
- FIPS 3-1/ANSI X3.22-1973: Recorded Magnetic Tape Information Interchange (800 CPI, NRZI)
- FIPS 13/ANSI X3.21-1967: Rectangular Holes in Twelve-row Punched Cards
- FIPS 14/ANSI X3.26-1980: Hollerith Punched Card Code
- FIPS 16-1/ANSI X3.15-1976: Bit Sequencing of the Code for Information Interchange in Serial-by-bit Data Transmission

Note: FED STD 1010 adopts FIPS 16-1

- FIPS 22-1/ANSI X3.1-1976: Synchronous Signaling Rates Between Data Terminal and Data Communication Equipment

Note: FED STD 1013 adopts FIPS 22-1

- FIPS 25/ANSI X3.39-1986: Recorded Magnetic Tape for Information Interchange (1600 CPI, Phase Encoded)
- FIPS 26/ANSI X3.18-1967: One Inch Perforated Paper Tape for Information Interchange

- FIPS 37/ANSI X3.36-1975: Synchronous High Speed Data Signaling Rates Between Data Terminal Equipment and Data Communication Equipment

Note: FED STD 1001 adopts FIPS 37

- FIPS 50/ANSI X3.54-1986: Recorded Magnetic Tape for Information Interchange, 6250 CPI (246 CPMM), Group Coded Recording
- FIPS 79/ANSI X3.27-1987: Magnetic Tape Labels and File Structure for Information Interchange
- FIPS 86/ANSI X3.64-1979: Additional Controls for Use with American National Standard Code for Information Interchange
- Other FIPS not applicable

Note: Information regarding interchangeability of ANSI and FED standards with FIPS is contained in "ADP Telecommunications Standards Index," July 1988, published and maintained by the General Services Administration.

- ISO 646: ISO 7-bit Coded Character Set for Information Exchange
- ISO 1001: File Structure and Labeling of Magnetic Tapes For Information Interchange
- ISO 1863: Information Processing — 9-track, 12, 7 mm (0.5 in) wide magnetic tape for information interchange recorded at 32 rpmm (800 rpi)
- ISO 1864: Information Processing — Unrecorded 12, 7 mm (0.5 in) wide magnetic tape for information interchange — 35 ftpmm (800 ftpi) NRZI, 126 ftpmm (3 200 ftpi) phase encoded and 356 ftmm (9 042 ftpi), NRZI
- ISO 2022: Code Extension Techniques for Use with ISO 646
- ISO 3307: Representations of Time of the Day
- ISO 3788: Information Processing — 9-track, 12, 7 mm (0.5 in) wide magnetic tape for information interchange recorded at 63 rpmm (1 600 rpt), phase encoded
- ISO 4873: 8-bit Code for Information Interchange — Structure and Rules for Implementation
- ISO 5652: Recorded Magtape (6250)
- ISO 6429: Control Functions for Coded Character Sets

VMS Disk Block Requirements

Disk Space Requirements (Block Cluster Size = 2):

The disk block size for the VMS Operating System, Version 5.5 after installation is approximately 91,000 blocks. This figure includes 5,600 blocks for page and swap files. Most systems will require larger page and swap files. This figure also includes Help library files that are in data-compressed format. Most system managers choose to expand these files (for faster access). The expansion requires approximately 8,500 additional blocks.

At least 40,000 free blocks are required to upgrade from VMS V5.4 or V5.4-x to VMS V5.5.

To support full VMS, a system disk of greater than 100 MB is recommended. When a smaller disk is used, additional tailoring is required prior to installing some VMS options. This does not include the dump file space. Refer to *VMS Upgrade and Installation Procedures Manual* for information on tailoring.

VMS DECwindows Disk Block Requirements

The disk block size for the complete VMS DECwindows environment after installation is approximately 64,000 blocks. This is in addition to the 91,000 blocks required for the other components of the VMS Operating System environment. A subset of the DECwindows environment can be installed. For example, programming support need not be installed in a user environment.

The following list describes how many blocks are needed for each section:

- User environment and applications — 14,000 blocks. This section provides support for running VMS DECwindows applications on VAX compute servers.
- Workstation device support — 15,000 blocks. This number includes 2,300 blocks for the 75 dpi fonts and 2,800 blocks for the 100 dpi fonts. On 75 dpi systems, the 100 dpi fonts do not have to be installed. On 100 dpi systems, both sets of fonts must be installed.
- Programming support — 32,000 blocks (approximately 3,500 per language). This number includes support for all the programming languages. If only a subset of languages is installed, the amount of disk space will be less.
- Example files — approximately 3,000 blocks.

Note that the individual sizes add up to more than the total because some components are shared by multiple portions of the environment.

To support full VMS and full VMS DECwindows, a system disk of greater than 115 MB is recommended. When a smaller disk is used, additional tailoring is required prior to installing some VMS and VMS DECwindows options. Refer to the *VMS Upgrade and Installation Procedures Manual* for information on tailoring.

The VMS DECwindows software installation is an optional step in the VMS installation or upgrade procedure. It has been designed this way to allow users who do not need the VMS DECwindows software to conserve disk space and to allow systems with less than minimum configuration requirements to continue to run VMS. Please refer to the *VMS Installation and Upgrade Procedures Manual* for details concerning the partial installation of the VMS DECwindows software.

Memory Requirements

The following tables describe the minimum amount of memory required for a system user to install, boot, and login to a VMS system. To ensure satisfactory performance of applications, additional memory will be required.

The minimum amount of memory supported for a stand-alone VMS system is 2 MB. This first table contains the minimum amount of additional memory required for the following components to be installed on a VMS system.

Component	Necessary Memory
DECnet	.5 MB
VAXcluster	1.5 MB
DECwindows with remote execution of applications	1.5 MB
DECwindows with local execution of applications	2.0 MB

Two example configurations based on the previous table are:

System	Minimum Supported Memory
DECwindows with applications executing remotely, and DECnet	4.0 MB
DECwindows with applications executing locally, VAXcluster and DECnet	6.0 MB

Note: These are the minimum memory requirements. More memory will be required for satisfactory performance of the operating system and DECwindows applications. The performance and memory usage of VMS DECwindows systems is particularly sensitive to system

configuration and window and application usage. Remote execution of an application requires an additional system that runs the application while the display of the application occurs on the local workstation.

Please refer to specific layered product Software Product Descriptions for their memory requirements.

Please refer to the VMS documentation for more information on performance.

GROWTH CONSIDERATIONS

The minimum hardware/software requirements for any future version of this product may be different from the requirements for the current version.

DISTRIBUTION MEDIA

Compact Disc

9-track 1600 BPI Magnetic tape, TK50 Streaming Tape

The VMS Operating System is also available as part of the VMS Consolidated Software Distribution on CDROM.

The VMS Documentation is also available as part of the VMS Online Documentation Library on CDROM.

DOCUMENTATION

Extensive documentation is available for VMS. The documentation is organized into functional subkits, based on usage. For example, all system management manuals are in one subkit. An easy-to-use desk-top set of manuals is also available for users who do not require extensive documentation.

Documentation for VMS DECwindows is available in two different sets. The VMS DECwindows User Kit is for the end user and the VMS DECwindows Programming Kit is for the DECwindows software developer.

In addition, the VMS Online Documentation Library compact disc contains the following VMS documentation, which can be read using the DECwindows Bookreader application:

- VMS Base Documentation Set
- VMS Extended Documentation Set
- VMS DECwindows User Kit and Programmer Kit*
- Selected VMS Layered Product Documentation

* With the exception of the Adobe PostScript Documentation, which is not available online.

ORDERING INFORMATION

This section contains order numbers for VMS media, licenses, documentation, and services.

Software License: QL-001A*-**

Media and Documentation

With Base Documentation Set: QA-09SA*-H*

With Extended Documentation Set: QA-001A*-H*

Additional Media

VMS Consolidated Software Distribution on

CDROM: QA-VWJ8A-A8

Additional Documentation Sets

Base Documentation Set: QA-09SAA-GZ

Extended Documentation Set: QA-001AA-GZ

DECwindows User Kit Documentation:¹

QA-09SAB-GZ

DECwindows Programmers Kit Documentation:

QA-001AM-GZ

VMS Online Documentation Library on Compact Disc:

QA-VYR8A-G8

¹Included in both VMS Base Documentation and Extended Documentation Sets.

Software Product Services

Software Support Service:² QT-001A*-**

²A variety of integrated and a la carte Hardware and Software Products are available. For additional information, please contact your local office.

Media and Documentation Update Service

With Base Documentation Set: QT-09SA*-E*

With Extended Documentation Set: QT-001A*-E*

Additional Media Update Service

VMS Consolidated Software Distribution on

CDROM: QT-VWJ8A-C8

Documentation Only Update Service

Base Documentation Set: QT-09SAA-KZ

Extended Documentation Set: QT-001AA-KZ

DECwindows Programmers Kit Documentation:

QT-001AM-KZ

VMS Online Documentation Library on Compact Disc:

QT-VYR8A-C8

The Software Media and Extended Documentation Set (QA-001A*-H*) is recommended for users managing high-end VAX systems, e.g., VAX 8600 or VAX 8830, VAXcluster systems, or DECnet-VAX networks. The Software Media and Base Documentation Set (QA-09SA*-H*) is recommended for managers of small standalone systems and for general end-users.

* Denotes variant fields. For additional information on available licenses, services, and media, refer to the appropriate price book.

SOFTWARE LICENSING

The VMS software is furnished under the licensing provisions of Digital's Standard Terms and Conditions.

The VMS license also includes the license for the VAX Rdb/VMS Run-Time Option. This allows the running of an application developed using VAX Rdb/VMS. However, VAX Rdb/VMS has separate media and documentation. In addition, should a user want to perform Rdb development, a separate license must be purchased. Refer to SPD 25.59.xx for further information.

Integral to VMS is support for the VMS DECwindows desktop environment. VMS DECwindows is based on the X User Interface (XUI) and is delivered as a component of the VMS Operating System, requiring no separate license. Additionally, Digital offers a new separately orderable layered product called VMS DECwindows Motif. VMS DECwindows Motif provides support for both OSF/Motif, an open standard that is the new default user interface, and the X User Interface in a single run-time and development environment. Refer to the VMS DECwindows Motif SPD (SPD 36.09.xx) for more information.

Customers who wish to run DECwindows over TCP/IP need only purchase the VMS/ULTRIX Connection product media and documentation kit. A separate license is not required. Customers who want to utilize the full VMS/ULTRIX Connection functionality (FTP, NFS, TELNET) do need to purchase a separate license. Refer to the VMS/ULTRIX Connection System Support Addendum (SSA 25.A4.xx-x) for required versions.

Please see the *Third Party Licensing* section in Appendix C for information regarding the Adobe licensing.

The System Integrated Products (SIPs), VAXcluster Software (SPD 29.78.xx), DECnet-VAX (SPD 25.03.xx), VAX Volume Shadowing (SPD 27.29.xx), and VAX RMS Journaling (SPD 27.58.xx) are separately licensed products. Please refer to the appropriate product's SPD for more information.

VMS License Information

The VMS Operating System uses one of four different types of licenses depending on the hardware and software configurations used and currently supported. This information is also provided in the applicable country's Price List.

Digital provides the proper license type with the purchase of the system. However, all VMS license types are not available for all system models.

These are the four types of VMS licenses:

1. VMS Availability License

This type of license provides unlimited use to the users on a defined system. These licenses are sometimes referred to as capacity licenses. VMS availability licenses are sized according to system type.

2. VMS Multiuser License

This type of license provides use according to a specified number of concurrent users. This is an activity-based license. The Operating System User License provides the customer with the right to use the operating system up to the limit of users specified in the license. An Operating System "User" is a person who is logged onto the system and is using the system interactively. Interactive use of the operating system includes the display of information upon any video or hardcopy display product whether in a DECwindows/X Windows environment or otherwise.

3. VMS Workstation License

This type of license provides use for a single user on a VAX Workstation.

4. VMS File and Application Server License

This type of license provides for the non-interactive use of VMS.

VAX VMS-based VAXservers are sold with a VMS File and Application Server License. The intent of a VAX VMS-based VAXserver is to provide file, print, application, and compute "services" to "clients" who have remotely submitted their requests (for example via network/remote submit/batch jobs, etc.).

The software licensing implications are that no direct operating system log-ons are intended on the VAX VMS-based VAXserver. One direct log-on is allowed for system management purposes only.

While remote submission of VAX VMS-based layered products for execution on a VAX VMS-based VAXserver is allowed, interactive use (direct log-on and execution) of VAX VMS-based layered products is prohibited.

All VMS licenses provide the right to use only the VMS features, functionality, and facilities provided by the current version license. Any features, functionality, and facilities not specifically licensed in the purchased version of VMS may not be used if a prior version kit containing such unlicensed features is installed.

Not all VMS license types are available for all versions of VMS or all VAX models.

License Management Facility Support

The VMS Operating System supports the License Management Facility.

If no VMS license is registered and activated using the License Management Facility, then a single login is permitted for system management purposes through the system console (OPA0:).

Several of the VMS license types are based on the number of concurrent users, called an activity license. Every product has the option to define an activity as related to the License Management Facility. VMS defines activities, sometimes referred to as VMS "users," as follows:

- Each remote terminal connection is considered an activity. This is true even if you set host to your local node (SET HOST 0).
- Each connection from a terminal server is considered an activity.
- A multiple-window session on a workstation is considered one activity, regardless of the number of windows.
- A batch job is not considered an activity.
- A remote network connection that is a connection other than a remote terminal connection, is not considered an activity.

For more information about Digital's licensing terms and policies, contact your local Digital office.

SOFTWARE PRODUCT SERVICES

A variety of service options are available from Digital. For more information, contact your local Digital office.

SOFTWARE WARRANTY

Warranty for this software product is provided by Digital with the purchase of a license for the product as defined in the Software Warranty Addendum of this SPD and the applicable Digital Standard Terms and Conditions.

SUPPORTED HARDWARE FOR VMS, VMS DECwindows, VAXcluster, and DECnet-VAX

This section of the SPD contains four parts: Hardware Charts, *Appendix A*, *Appendix B*, and *Appendix C*.

The charts list the hardware that VMS, VMS DECwindows, DECnet-VAX, and VAXcluster Software supports. Combinations of hardware options are subject to limitations such as bandwidth, physical configuration constraints, and electrical load and power supply.

Appendix A describes system-specific restrictions for the configurations listed.

Appendix B describes Digital terminals, disks, tapes, controllers, communications options, and VAXcluster options. Some restrictions for specific devices are listed if applicable.

The content of this hardware configuration appendix is intended to specify the device limitations and provide a general guide. It does not describe all possible hardware configurations or circumstances. Any particular configuration should be discussed with Digital. Contact Digital for the most up-to-date information on possible hardware configurations.

Digital reserves the right to change the number and type of devices supported by VMS, VMS DECwindows, DECnet-VAX, and VAXcluster Software. The minimum hardware requirements for future versions and updates of VMS, VMS DECwindows, DECnet-VAX, and VAXcluster Software may be different from current hardware requirements. For configuration details about VAX hardware, refer to the *VAX System and Options Catalog* and the *Networks and Communications Buyers Guide*.

Refer to the individual SPDs for DECnet-VAX (SPD 25.03.xx) and VAXcluster Software (SPD 29.78.xx) for detailed product information.

How to Read the Charts

The first column lists the VAX system, the media (tape, disk, or compact disc) from which the VMS Operating System can be loaded onto the system disk, and the maximum number of busses supported on the system.

The second column lists the disk controllers and drives that can be used on the system. A disk controller can be used with any disk drive listed next to it: for example, on a MicroVAX II or VAXstation II system the RQDX3 disk controller can be used with an RD52, RD53, RD54, RX50, or RX33 disk drive.

The third column lists the tape controllers and drives that can be used on the system. The tape controller can be used with any tape drive listed next to it: for example, on a MicroVAX II or VAXstation II system, the TK50 controller can be used with the TK50 tape drive.

The fourth and fifth columns list the communications and VAXcluster options available for the systems. The listed Ethernet devices can also be used for network connections.

The sixth column lists other hardware that can be used and the maximum amount of memory allowed on the systems in each category.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE				
MicroVAX II, VAXstation II	KDA50 RQDX2	RA-series* RD51 RD52 RD53 RX50 RD52 RD53 RD54 RX50 RX33	TQK50 TQK70 TSV05 KLESI TU81-Plus* RV20*	TK50 TK70 TS05 DZV11 DHV11* DHQ11 DZQ11	Asynch-	CXA16*+ CXB16*+ CXY08* DZV11	DEQNA DELQA DESQ#	DRV11-WA* LPV11 VCB01-KP (VsII) VCB02-B (VsII/GPX) VCB02-D (VsII/GPX) RQDXE
(Load Media) TK50 Magtape RX33## CDROM (BUSSES) 1 Q-bus 2 DSSI**	RQDX3	RD52 RD53 RD54 RX50 RX33 KRQ50 RRD50 RRD40 KLESI RC25 (DSSI) RF30 RF71			Synch-	DMV11 DSV11		16 MB Max Mem

* Can be used on a MicroVAX II system only.

** Only available via the KFQSA.

+ DECnet-VAX does not support these options.

Only available with BA200-series enclosures.

VMS distribution on this media has been retired.

MicroVAX 2000	Integral	RD32 RD53	TZK50	TK50	Asynch-	DST32*+ DSH32	Integral	VS40X (Vs2000)
VAXstation 2000		RD54						14 MB Max Mem
(Load Media) TK50 RX33#		RX33			Synch-	DST32*+ DSH32*		
(BUSSES) N/A								

* Can be used on a MicroVAX 2000 system only.

VMS distribution on this media has been retired.

+ Concurrent use of the DST32 and the DHT32 is not supported. Supports Display PostScript.

MicroVAX 3100	Integral	RX23 RZ23	TKZ50	TK50Z TZ30	DSH32 (1 sync. & 8 lines)		Integral	32 MB Max Mem
VAXserver 3100 Models		RZ24		TLZ04				
10/10e		RZ25		TZK10	async. lines)			
20/20e		RZ55						
(Load Me- dia*)		RZ56						
TK50		RZ57						
CDROM		RRD40 RRD42						
(BUSSES) Integral SCSI		RX26						
RZ23L								

* Factory-loaded software on all configurations that include RZ23L, RZ24, and RZ25 internal disks.

System	Disks		Tapes		Communication (WAN)	Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE			
MicroVAX 3100 Models 30/40/80	Integral	RX33+		TK50Z	DHW41-AA	Integral	Models 30/40 32 MB Max Mem
(Load Me- dia*)		RZ24		TZ30	DHW41-BA		
TK50		RZ25		TLZ04	DHW42-AA		
CDROM		RZ55+		TZK10	DHW42-BA		
(BUSSES) Integral SCSI		RZ56+			DHW42-UP		Model 80
		RZ57+			DHW42-CA		72 MB Max
		RZ58+			DSW41-AA		Mem
		RRD42++			DSW42-AA		
		RX26					
		RZ23L					

*Factory-loaded software on all configurations that include RZ23L, RZ24, and RZ25 internal disks

+External device only

++External/Internal for Models 40 and 80. External only for Model 30.

VAXstation 3100 Series	Integral	RZ22	Integral	TK50Z		Integral	WS01X VCB02 Graphics VS40X-PA Graphics Coprocessor
		RZ23		TZ30			
(Load Media)		RZ24					
TK50		RZ55					
CDROM		RZ56					
		RRD40					
(BUS) SCSI		RX23					32 MB Max Mem

Supports Display PostScript.

VAXstation 3200	RQDX3	RD53	TQK50	TK50	Asynch-	DHV11	DELQA	Graphics Sub- system for the Vs3200
		RD54	TSV05	TS05		DZQ11		
(Load Media)	KRQ50	RRD40			Synch-	DSV11		
TK50		RRD50						
CDROM								32MB Max Mem
(BUS) 1 Q-bus								

Supports Display PostScript.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE				
MicroVAX 3300/3400	Integral	RF30	TQK70	TK70	Asynch-	CXA16+		
		RF31	TQK50	TK50		CXB16+		
VAXserver 3300/3400	KFQSA	RF31F	KFQSA	TF85		CXY08		
		RF71		TF857				
(Load Media)	KRQ50	RF72	TSV05	TS05	Synch-	DSV11		
TK50		RRD40	KLESI	TU81-Plus				
CDROM	KZQSA	RRD42						
Magtape		TLZ04						
		KDA50	RA-series					
(BUSES)								
1 DSSI*								
1 Q-bus								

* Second DSSI available only via the KFQSA.

+ DECnet-VAX does not support these options.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

MicroVAX 3500	RQDX3	RD53*	TQK70	TK70	Asynch-	CXA16+	DELQA	Graphics Sub-system for the Vs3500
		RD54*	TQK50	TK50		CXB16+	DESQA	
VAXserver 3500	KDA50	RA-series	TSV05	TS05		CXY08		
	KRQ50	RRD40		TF85				
VAXstation 3500		RRD50		TF857	Synch-	DSV11		64MB Max Mem
	KZQSA	RRD42	KFQSA	TU81-Plus				
		TLZ04	KLESI					
(Load Media)	KFQSA	RF30	RV20					
TK50		RF31						
Magtape		FR31F						
CDROM		RF71						
		RF72						
(BUSES)								
1 Q-bus								
1 DSSI **								

* Available on MicroVAX 3500 system only.

+ DECnet-VAX does not support these options.

** Only available via the KFQSA. Supports Display PostScript.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

VAXstation 3520	I/O Adapter	RZ55	TQK70	TK70	Asynch-	CXA16+	Integral	Graphic Subsystem for the Vs3520/3540 VCB03 optional graphics
VAXstation 3540		RZ56				CXB16+		
		RRD40				CXY08		
(Load Media)					Synch-	DSV11		
TK50								
CDROM								
(BUSES)								
1 SCSI								
1 Q-bus								

Supports Display PostScript.

+ DECnet-VAX does not support these options.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE	Asynch-	CXA16+ CXB16+ CXY08		
MicroVAX 3600	KDA50	RA-series	TQK70	TK70			DELQA DESQA	64 MB Max Mem
VAXserver 3600	KRQ50	RRD40	TQK50	TK50				
		RRD50	TSV05	TS05				
	KZQSA	RRD42	KLESI	TU81-Plus				
VAXserver 3602		TLZ04	KFQSA	RV20			Synch-	DSV11
		RF30		TF85				
		RF31		TF857				
(Load Media)		RF31F						
TK50		RF71						
Magtape		RF72						
CDROM								
(BUSSES)								
1 Q-bus								
1 DSSI**								

+ DECnet-VAX does not support these options.

** Only available via the KFQSA.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

MicroVAX 3800	KFQSA	RF30	TQK70	TK70	Asynch-	CXA16+ CXB16+ CXY08	DESQA DELQA	64 MB Max Mem
VAXserver 3800		RF31	TQK50	TK50				
		RF31F	TSV05	TS05				
		RF71	KLESI	TU81-Plus				
		RF72	KFQSA	TF85			Synch-	DSV11
(Load Media)	KRQ50	RRD40		TF857				
TK50		RRD50						
CDROM	KZQSA	RRD42						
		TLZ04						
(BUSSES)	KDA50	RA-series						
1 Q-bus								
1 DSSI*								

* Only available via the KFQSA.

+ DECnet-VAX does not support these options.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

MicroVAX 3900	KDA50	RA-series	TQK70	TK70	Asynch-	CXA16+ CXB16+ CXY08	DESQA DELQA	64 MB Max Mem
VAXserver 3900	KRQ50	RRD40	TQK50	TK50				
		RRD50	KLESI	TU81-Plus				
	KZQSA	RRD42	TSV05	TS05				
		TLZ04	KFQSA	TF85			Synch-	DSV11
(Load Media)	KFQSA	RF30		TF857				
TK50		RF31						
CDROM		RF31F						
Magtape		RF71						
		RF72						
(BUS)								
1 Q-bus								
1 DSSI*								

* Only available via the KFQSA.

+ DECnet-VAX does not support these options.

Note: Refer to the Systems and Options Catalog for listing of supported Q-bus options.

System	Disks		Tapes		Communication		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE	(WAN)			
VAXstation 4000* Models 60/VLC (Load Media) TK50 CDROM (BUS) SCSI	Integral	RZ22	Integral	TK50Z	Synch-	DSW21	Integral (Ethernet)	PV21X (Model 60) Graphics
		RZ23		TZ30		DWCTX-		PV31G (VLC)
		RZ24		TZK10		BX		Graphics
		RZ25				(TURBO		PV61G (Model
		RZ55				channel		60) Graphics
		RZ56				adapter)		VSXXX-AA
		RRD40						mouse
		RX23						VSXXX-GA
		RZ57						mouse
		TLZ04						VSX10 dial
		RZ58						/button box
		RX26						VSX20 button
		RX33						box
		RRD42						VSX30 dial box
								LK201
								LK401
								VLC 24 MB
								Max Mem
								Model 60
								104 MB Max
								Mem

*Factory-loaded software on all configurations that include internal disks (RZ231, RZ24, and RZ25)

VAX-11/730 (Load Media) RL02* Magtape (BUS) 1 UNIBUS	UDA50 RK711 RL211 RX211 RUX50 (Integral) IDC	RA-series RK07 RL02 RX02 RX50 RL02 R80	TS11 TUK50 KLESI TU81 TU81-Plus TA-series	TS11 TU80 TU81 TU81-Plus RV20 TK50 TA-series	Asynch- DZ11 DZ32 DMZ32 DHU11 Synch- DMF32 DMR11	DMF32 DZ11 DZ32 DMZ32 DHU11 DMF32 DMR11	DEUNA+ DELUA+ (CI) CI750 DMF32 DEUNA DELUA (CI) CI750 DMF32 DMR11	CR11 DR11-W DMF32-LP LP11 LPA11 FP730 5 MB Max Mem
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* VMS distribution on this media has been retired.

+ VAX-11/730 systems are not supported in VAXcluster systems.

VAX-11/750 (Load Media) RL02* RK07* RA60* Magtape (BUSES) 2 UNIBUS 3 MASSBUS (CI) HSC	UDA50 RK711 RL211 RX211 KLESI RC25 RUX50 RM03 RM05 RM80 RP06 RP07 ESE-20 RA-series	RA-series RK07 RL02 RX02 KLESI RC25 TUK50 RM03 (CI) HSC TM03 TM78 TA-series	TS11 TU80 TU81 TU81-Plus RV20 TK50 TA-series	TS11 TU80 TU81 TU81-Plus RV20 TK50 TA-series	Asynch- DZ11 DZ32 DMZ32 DHU11 Synch- DMF32 DMR11	DMF32 DZ11 DZ32 DMZ32 DHU11 DMF32 DMR11	DEUNA DELUA (CI) CI750 DMF32 DEUNA DELUA (CI) CI750 DMF32 DMR11	DMF32-LP DR11-W DR750 DW750 FP750 H7112 KU750 LPA11 RH750 LP11 14 MB Max Mem
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* VMS is not distributed on this media type.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE	Asynch-	DMF32		
VAX-11/780	UDA50	RA-series	TS11	TS11			DEUNA	DM32-FP
VAX-11/785	RK711	RK06	KLESI	TU80		DZ11	DELUA	DR11-W
	RL211	RK07		TU81		DMZ32	(CI)	DR780
(Load Media)	RX211	RL02		TU81-Plus		DHU11	CI780	DW780
RK07*	KLESI	RX02		RV20				H7112
RA60*	RUX50	RC25	TUK50	TK50	Synch-	DMF32		FP780**
Magtape		RX50		TA-series		DMR11		FP785***
		RM03	(CI)					KE780**
(BUSES)		RM05	HCS					KU780**
4 UNIBUS		RM80	TM03	TE16				RH780
4 MASSBUS		RP05	TM78	TU45				LP11
		RP06		TU77				
		RP07		TU78				
(CI)								64 MB Max Mem
HCS		ESE-20						
		RA-series						

* VMS is not distributed on this media.

** These options are used on the VAX-11/780 only.

*** Used on the VAX-11/785.

VAXft Models 110 /310	KFE52	RF31 RF72	KFE52	TF70	Synch-	DSF32	Integral	128 MB Max Mem
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(Load Media)
TK50
CDROM via
InfoServer

(Busses)
2 DSSI

VAXft Models 410 /610/ 612	KFE52	RF31 RF72 RF73	KFE52 (Model 610/612 only) KFQSA	TF70 TF85 TF857	Synch-	DSF32	Integral	256 MB Max Mem
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(Load Media)
TK50
CDROM via
InfoServer

(Busses)
2 DSSI

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE				
VAX 4000	Integral &	RF30	TQK50	RSV20	Asynch-	CXA16+	Integral	64 MB Max
Model 200	KFQSA	RF31	TQK70	TF85		CXB16+	DELQA	Mem
(Load Media)		RF31F	TSV05	TF857		CXY08	DESQA	
TK50		RF35	KLESI	TLZ04				
CDROM		RF71	KZQSA	TS05	Synch-	DPV11		
		RF72	Integral	TSZ07		DSV11		
(BUS)	KDA50	RA-series	&	TK50				
1 Q-bus	KRQ50	RRD40	KFQSA	TK70				
4 DSSI	KZQSA	RRD42		TU81-Plus				

Note: Factory loaded software on all configurations that contain a disk.

VAX 4000	Integral &	RF30	TQK70	TK70	Asynch-	CXA16+	Integral	256 MB Max
Model 300	KFQSA	RF31	TQK50	TS05		DESQA	DELQA	Mem
(Load Media)		RF71	TSV05	TU81-Plus	Synch-	CXB16+		
TK50		RF31F	KLESI	TK50		CXY08		
CDROM		RF72	KZQSA	RSV20		DSV11		
		RF73	Integral	TLZ04		DPV11		
(BUS)	KDA50	RA-series	&	TSZ07				
1 Q-bus	KRQ50	RRD40	KFQSA	TF85				
4 DSSI	KZQSA	RRD42		TF857				

Note: Factory loaded software on all configurations that contain a disk.

VAX 4000	Integral &	RF30	TQK50	RSV20	Asynch-	CXA16+	Integral	512 MB Max
Model 500	KFQSA	RF31	TQK70	TF85		DESQA	DELQA	Mem
(Load Media)		RF31F	TSV05	TF857	Synch-	CXB16+	DESQA	
TK50		RF35	KLESI	TLZ04		CXY08		
CDROM		RF71	KZQSA	TS05		DPV11		
		RF72	Integral	TSZ07		DSV11		
(BUS)	KDA50	RA-series	&	TK50				
1 Q-bus	KRQ50	RRD40	KFQSA	TK70				
4 DSSI	KZQSA	RRD42		TU81-Plus				

Note: Factory loaded software on all configurations that contain a disk.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE	Asynch-	DSB32		
VAX 6000-200 Series+	KDB50	RA-series	KLESI	TU81-Plus		DMB32	DEBNA	LP11*
	KDM70		TBK50	RV20		DHB32	DEBNI	DMB32-LP
VAXserver 6000-210	TM32		TBK70	TK50			DEMNA	DR11-W*
(CI)				TK70	Synch-	DMB32	DEMFA	DWMUA*
VAXserver 6000-220	HSC	ESE-20	(CI)	HSC		DSB32	(CI)	DRB32
		RA-series		KDM70	TA-series		CIBCA-AA	
(Load Media)							CIBCA-BA	
TK50							CIXCD-AB	512 MB Max Mem
Magtape								
CDROM via InfoServer								
(BUSES)								
6 VAXBI								
1 UNIBUS								
2 VME								
(DWMVA)								
KFMSA								

+ Formerly named the VAX 6210, 6220, 6230, 6240.

* Supported on the VAX 6000-210 and VAX 6000-220 systems only.

VAX 6000-300 Series+	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DMB32	DEBNA	LP11*
	KDM70		TBK50	TK50		DHB32	DEBNI	DMB32-M
VAXserver 6000-310	TM32		TBK70	TK70			DEMNA	DR11-W*
/320	(CI)		(CI)				DEMFA	DRB32
	HSC	ESE-20	HSC	TA-series	Synch-	DMB32	(CI)	DWMUA*
		RA-series	KDM70			DSB32	CIBCA-AA	
(Load Media)							CIBCA-BA	
TK50							CIXCD-AB	512 MB Max Mem
Magtape								
CDROM via InfoServer								
(BUSES)								
6 VAXBI								
1 UNIBUS*								
2 VME								
(DWMVA)								
KFMSA								

+ Formerly named the VAX 6310, 6320, 6330, 6340, 6360.

* Supported on the VAX 6000-310 and VAX 6000-320 systems only.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE	Asynch-	DMB32		
VAX 6000-400 Series	KDB50 KDM70	RA-series	KLESI TBK70 TBK50 (CI) HSC	TU80-Plus TK70 TK50 TA-series	Asynch- DHB32 Synch- DSB32	DEBNA DEMNA DEMFA (CI) CIBCA-BA	LPA11 DR11-W FV64A DMB32 DRB32	
(Load Media) TK50 Magtape CDROM via InfoServer						CIXCD-AB	512 MB Max Mem	
(BUSSES) 6 VAXBI 1 UNIBUS 2 VME (DWMVA) KFMSA								
VAX 6000-500 Series	KDB50 KDM70	RA-series	KLESI TBK70 TBK50 (CI) HSC	TU80-Plus TK70 TK50 TA-series	Asynch- DHB32 Synch- DSB32	DEBNA DEMNA DEMFA (CI) CIBCA-BA	LPA11 DR11-W FV64A DMB32 DRB32	
(Load Media) TK50 Magtape CDROM via InfoServer						CIXCD-AB	512 MB Max Mem	
(BUSSES) 6 VAXBI 2 VME (DWMVA) KFMSA								
VAX 6000-600 Series	KDB50 KDM70 TM32	RA-series	KLESI TBK70 TBK50 (CI) HSC	TU80-Plus TK70 TK50 TA-series	Asynch- DHB32 Synch- DSB32	DEBNA DEMNA DEMFA (CI) CIBCA-BA	FV64A DMB32 DRB32	
(Load Media) TK50 Magtape CDROM via InfoServer						CIXCD-AB	512 MB Max Mem	
(BUSSES) 6 VAXBI 2 VME (DWMVA) KFMSA								

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE				
VAX 8200	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DHB32	DEBNA	DMB32-LP
VAX 8250	(CI)	HSC	ESE-20	TM32	RV20	DMB32	DEBNI	DR11-W
(Load Media)			RA-series	TS11	RV64	DHU11	DELUA	DWBUA
Magtape				TUK50	TU80	DMF32	(CI)	DRB32
RA60*				TBK50	TU81	DMZ32	CIBCA-AA	LP11
TK50					TU81-Plus		CIBCA-BA	
(BUSSES)						Synch-	DMB32	CIBCI
1 VAXBI							DSB32	128 MB Max Mem
1 UNIBUS								

* VMS Operating System is not distributed on RA60 media.

VAX 8300	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DHB32	DEBNA	DMB32-LP
VAX 8350	(CI)	HSC	ESE-20	TM32	RV20	DMB32	DEBNI	DR11-W
(Load Media)			RA-series	TS11	RV64	DHU11	DELUA	DWBUA
Magtape				TUK50	TU80	DMF32	(CI)	DRB32
RA60*				TBK50	TU81-Plus	DMZ32	CIBCA-AA	LP11
TK50						Synch-	CIBCA-BA	
(BUSSES)							DMB32	CIBCI
1 VAXBI							DSB32	128 MB Max Mem
1 UNIBUS								

* VMS Operating System is not distributed on RA60 media.

VAX 85xx	KDB50	RA-series	KLESI	TU81-Plus	Asynch-	DHB32	DEBNA	DMB32-LP
(Load Media)	(CI)	HSC	ESE-20	TM32	RV20	DMB32	DEBNI	DR11-W
Magtape			RA-series	TS11	RV64	DHU11	DELUA	DWBUA
(BUSSES)				TUK50	TU80	DMF32	(CI)	DRB32
2 VAXBI				TBK50	TU81	DMZ32	CIBCA-AA	LP11
1 UNIBUS					TU81-Plus	Synch-	CIBCA-BA	
							DMB32	CIBCI
							DSB32	256 MB Max Mem

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE				
VAX 8600	UDA50	RA-series	TS11	TS11	Asynch-	DMF32	DEUNA	DMF32-LP
VAX 8650	RL211	RL02	KLESI	TU80		DZ11	DELUA	DR11-W
(Load Media)	RX211	RX02	TUK50	TU81		DZ32	(CI)	DR780
Magtape	RUX50	RX50		TU81-Plus		DMZ32	CI780	DW780
	KLESI	RC25	(CI)			DHU11		FP86-AA
		RM03	HSC	RV20				RH780
(BUSES)		RM05		TK50	Synch-	DMF32		
7 UNIBUS		RM80		TA-series		DMR11		260 MB Max
6 MASSBUS		RP05	TM03	TE16				Mem
2 SBI		RP06	RM78	TU77				
		RP07		TU78				
(Integral)			IDTC	TU81				
IDTC		RA60						
(CI)		RA80						
HSC		RA81						
		RA82						
		ESE-20						
		RA-series						
VAX 8700	KD850	RA-series	KLESI	TU81-Plus	Asynch-	DHB32	DEBNA	DMB32-LP
VAX 8800	(CI)			RV20		DMB32	DEBNI	DR11-W
(Load Media)	HSC	ESE-20		RV64		DMF32	DELUA	DRB32
Magtape		RA-series	(CI)			DMZ32	(CI)	DWBUA
			HSC	TA-series			CIBCA-AA	LP11
(BUSES)					Synch-	DMB32	CIBCA-BA	
4 VAXBI						DSB32	CIBCI	512 MB Max
2 UNIBUS								Mem
VAX 8810*	KD850	RA-series	KLESI	TU81-Plus	Asynch-	DMB32	DEBNA	DMB32-LP
VAX 8820	(CI)			RV20		DHB32	DEBNI	DR11-W
VAX 8830	HSC	ESE-20		RV64			(CI)	DWBUA
VAX 8840		RA-series			Synch-	DMB32	CIBCA-AA	DRB32
(Load Media)						DSB32	CIBCA-BA	LP11
Magtape							CIBCI**	
(BUSES)								512 MB Max
6 VAXBI								Mem
1 UNIBUS								

* The VAX 8810 can support a maximum of 4 VAXBIs.

** Supported only on the VAX 8810.

System	Disks		Tapes		Communication (WAN)		Options (LAN/CI)	Miscellaneous
	CTRL	DRIVE	CTRL	DRIVE				
VAX 9000-110/210	KDM70 (6 max)	RA-series ESE-20	KLESI (2 max)	RV20 RV64	Asynch-	DMB32 (2 max)	DEMNA (4 max)	DRB32-M/E/W /-C (2 max)
VAX 9000-310/410	HSC	ESE-20 RA-series	KDM70 KFMSA (2 max)	TA-series RF-series TF-series	FDDI-	DHB32 (2 max)	CIXCD (4 max)	DWMBB-HA-CA/JA (VAXBI) EXP KDB50 (2 max)
(Load Media)						DEMFA (4 max)	DEBNI (3 max)	DSB32-M (2 max)
Magtape					Synch-	DMB32		
CDROM via InfoServer						DSB32		
(BUSSES)								512 MB Max Mem
1 XMI								
4 VAXBI								

NOTE: The VMS software that runs on the MicroVAX console subsystem is licensed for use only with standard console activities. No other use is intended or implied.

Appendix A

This appendix describes some restrictions to the system configurations listed in the charts. See the *VAX System and Options Catalog* and the *Network and Communications Buyers Guide* for details of VAX hardware configurations.

MicroVAX I/VAXstation I Systems

The final version of VMS that supports these systems is VMS V5.1-1.

MicroVAX II System

The CX-series boards and DESQA controller can be used in a BA213 cabinet only.

MicroVAX 2000 and VAXstation 2000 Systems

DECnet-VAX supports only one asynchronous data /modem RS-232C serial line up to 9600 baud on the integral 4 line asynchronous controller.

VAXserver 3602 System

The VAXserver 3602 is two VAXserver 3600 systems.

VAX-11/725

VMS V5.1 was the final version to support the VAX-11/725.

VAX-11/730 System

The VAX-11/730 system supports additional memory to a maximum of 5 MB for systems configured with R80/RL02 or dual RL02 disks. Other VAX-11/730 system configurations support a maximum of 3 MB of memory for the VAX-11/730 only.

A maximum of two RL02 disk drives can be added to the dual RL02 and the R80/RL02 configuration for VAX-11/730 only.

The VAX-11/730 system supports one UNIBUS magnetic tape subsystem.

Refer to the *Hardware System and Options Catalog* for the different hardware options supported on these systems.

The VMS DECwindows environment is not supported on these systems.

Appendix B

This appendix describes Digital Equipment Corporation terminals, disks, tapes, controllers, communications options, and VAXcluster options.

Terminals and Terminal Line Interfaces

To prevent input from overflowing a buffer, terminals use the ASCII control characters DC1 and DC3 for synchronization as defined by Digital's DEC STD 111, Revision A.

The following table lists the terminals that are supported by VMS:

VT52	VT100-series	LA-series
VT300-series	VT1000-series	LQP02
		VT200-series

Terminals on Professional 350, Rainbow 100, and DECmate II systems emulate VT100 terminals.

Only limited support is available for the VT52. The VT131, when running an application, operates in block mode. When interacting with VMS and its associated utilities, the VT131 only operates in VT100 (or interactive) mode and not in block mode.

Note: The VT1000 is a monochrome windowing terminal that supports standard ANSI applications and "X" windows. The transport protocols supported are LAT for VMS. The product supports 15 inch and 19 inch monitors.

Disks

To support full VMS, a system disk of greater than 100 MB is recommended. To support full VMS and full VMS DECwindows, a system disk of greater than 115 MB is recommended. When a smaller disk is used, additional tailoring is required prior to installing some VMS and VMS DECwindows options. This does not include the dump file space. Refer to the *Upgrade and Installation Procedures Manual* for information on tailoring. For the disks that have been introduced since the last edition of the VMS Operating System SPD, the minimum required version of VMS for these disks is listed.

ESE-20	120 MB solid state disk drive.	(MSCP)
RA60	205 MB removable disk drive.	(MSCP)
RA70	280 MB fixed disk drive.	(MSCP)
RA71	700 MB fixed disk drive.	(MSCP) (V5.4-2)
RA72	1 GB fixed disk drive.	(MSCP) (V5.4-2)
RA80	128 MB fixed disk drive.	(MSCP)

RA81	456 MB fixed disk drive.	(MSCP)	RP05**	88 MB removable disk drive.	(MASSBUS)
RA82	622 MB fixed disk drive.	(MSCP)	RP06	176 MB removable disk drive.	(MASSBUS)
RA90	1.2 GB fixed disk drive.	(MSCP)	RP07	516 MB fixed disk drive. (2.2 MB/sec transfer rate is supported if the RH780 is at REV B1 or greater for the VAX-11/780, VAX-11/785, VAX 8600 and VAX 8650.)	(MASSBUS)
RC25*	2 disks each 26 MB (1 fixed and 1 removable) disk drive with shared spindle.	(Q-bus, UNIBUS)			
RD32*	VAX 42 MB fixed disk drive for MicroVAX 2000 and VAXstation 2000.		RX02*	512 KB diskette drive. The RX02 drive also writes using single-density RX01 diskettes.	(UNIBUS)
RD51*	10 MB fixed disk drive.	(Q-bus)	RX23	1.47 MB diskette drive.	(SCSI)
RD52*	31 MB fixed disk drive.	(Q-bus)	RX26	2.8 MB diskette drive.	(SCSI) (V5.5)
RD53*	71 MB fixed disk drive.	(Q-bus, or Integral Controller on MicroVAX 2000)	RX33*	1.2 MB diskette drive. Requires minimum RQDX3 microcode of V3.0.	(Q-bus, or Integral Controller on MicroVAX 2000)
RD54	159 MB fixed disk drive.	(Q-bus, or Integral Controller on MicroVAX 2000)	RX50*	400 KB diskette drive.	(Q-bus, or Integral Controller on MicroVAX 2000)
RF30	150 MB fixed disk drive.	(DSSI)			
RF31F	200 MB fixed disk drive.	(DSSI) (V5.4-2)	RV20*	2 GB Write Once Read Many optical disk drive.	(Q-bus, UNIBUS, VAXBI)
RF31-JA	381 MB shockmounted removable disk drive.	(DSSI)	RV64*	2 GB Write Once Read Many optical disk subsystem.	(Q-bus, UNIBUS, VAXBI)
RF31-KA	381 MB fixed disk drive.	(DSSI)	RZ22*	52 MB fixed disk drive.	(SCSI)
RF35	800 MB fixed disk drive.	(DSSI) (V5.5)	RZ23**	104 MB fixed disk drive.	(SCSI)
RF71	400 MB fixed disk drive.	(DSSI)	RZ23L	121 MB fixed disk drive.	(SCSI) (V5.4-1)
RF73	2 GB fixed disk drive.	(DSSI) (V5.5)	RZ24	209 MB fixed disk drive.	(SCSI)
RK06*	14 MB removable disk drive.	(UNIBUS)	RZ25	425 MB fixed disk drive.	(SCSI) (V5.4-3)
RK07*	28 MB removable disk drive.	(UNIBUS)	RZ55	332 MB fixed disk drive.	(SCSI)
RL02*	10 MB removable disk drive.	(UNIBUS)	RZ56	665 MB fixed disk drive.	(SCSI)
RM03+	67 MB removable disk drive.	(MASSBUS)	RZ57	1 GB fixed disk drive.	(SCSI) (V5.4-3)
RM05	256 MB removable disk drive.	(MASSBUS)	RZ58	1.35 GB fixed disk drive.	(SCSI) (V5.5)
RM80	124 MB fixed disk drive.	(MASSBUS)			
R80**	124 MB fixed disk drive for VAX-11/725 and VAX-11/730.		*	Device cannot be used as a VMS system disk.	
RRD40*	600 MB read-only optical disk drive.	(Q-bus and SCSI)	**	Device cannot be used as a VMS system disk with VMS DECwindows environment.	
RRD42	600 MB read-only optical disk drive.	(SCSI) (V5.4-2)			
RRD50*	600 MB read-only optical disk drive.	(Q-bus)			

<i>Disk Options Supported by Digital's Services Enterprise Integration Center (SEIC)</i>			TU81-Plus	Streaming 9-track magnetic tape drive.	(Q-bus, UNIBUS, VAXBI)
RF30-RA	150 MB removable disk drive.	(DSSI)	TZ30	95 MB, 5 1/4 inch, half-height, tape drive.	(SCSI)
RF31-RA	381 MB removable disk drive.	(DSSI)	TZK10	320/525 MB QIC (quarter inch cartridge) tape drive.	(SCSI) (V5.4-2)
RF71-RA	400 MB removable disk drive.	(DSSI)	<i>Tape Options Supported by Digital's Services Enterprise Integration Center (SEIC)</i>		
RF71-RA	1 GB removable disk drive.	(DSSI)			
RWZ01	594 MB optical removable disk drive.	(SCSI) (V5.4-3)	TLZ08	5.25 inch, 2 GB, 8 mm tape drive.	(SCSI)
<i>Tapes</i>			TS05	9-track magnetic tape drive.	(Q-bus)
TA78	STI TU78.	(MSCP)	TSZ05	1600 BPI, 9 track tape drive.	(SCSI)
TA79	STI TU79.	(MSCP)	TSZ07	1600/6250 BPI, tape drive.	(SCSI) (V5.4-1)
TA81	STI TU81.	(MSCP)	<i>Controllers</i>		
TA90	1.2 GB, tape cartridge subsystem. (5 inch 200 MB cartridge)	(MSCP)	DMB32-LP	VAXBI DMA parallel high speed line printer controller.	
TA90E	1.2 GB tape cartridge subsystem. Compacts data records automatically.	(MSCP)	DRB32	High speed general purpose parallel interface for VAXBI (systems).	
TA91	High performance tape drive.	(MSCP) (V5.4-2)	DMF32-LP	Synchronous/Asynchronous communication option with printer port for use on UNIBUS based systems.	
TE16	9-track magnetic tape drive.	(MASSBUS)	HSC40	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version of 5.00.)	
TF70	290 MB TK70 tape cartridge drive.	(DSSI) (V5.4-2)	HSC50	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version 4.00.)	
TF85	2.6 GB streaming tape cartridge drive.	(DSSI) (V5.4-2)	HSC70	Hierarchical Storage Controller for MSCP disks and TMSCP tapes. (HSC Software must be a minimum Version 5.00.)	
TF857	18.2 GB tape cartridge loader.	(DSSI) (V5.4-2)	IDC	Integrated Disk Controller for VAX-11/725 and VAX-11/730 systems.	
TK50	95 MB, 5 1/4 inch streaming tape cartridge drive.	(Q-bus and SCSI)	IDTC	Integral Disk and Tape Controller for VAX 8600 and VAX 8650 systems.	
TK70	296 MB, 5 1/4 inch streaming tape cartridge drive.	(Q-bus)	LPA11-K	Microprocessor controller for laboratory acquisition I/O devices, accommodating up to two AD11-Ks, one AA11-K, one KW11-K, two AM11-Ks, and five DR11-Ks. One LPA11-K controller is supported per UNIBUS and a maximum of two are supported per system.	
TLZ04	4 GB, 3.5 inch, 4 mm tape drive.	(SCSI)	KDA50	Q-bus MSCP disk controller. The KDA50 disk controller supports up to four of the following drives: RA60, RA70, RA80, RA81, and RA82.	
TS11	9-track magnetic tape drive.	(UNIBUS)	KDB50	VAXBI MSCP disk controller. The KDB50 disk controller supports up to four of the following drives: RA60, RA80, RA81, and RA82.	
TU77	9-track magnetic tape drive.	(MASSBUS)			
TU78	9-track magnetic tape drive.	(MASSBUS)			
TU80	9-track magnetic tape drive.	(UNIBUS)			
TU81	9-track magnetic tape drive.	(UNIBUS)			

KDM70	The KDM70 is an intelligent MSCP/TMSCP mass-storage controller that supports RA Series Disks and Storage Arrays, TA Series Tape, and ESE20.	TBK70	BI-bus tape controller for the TK70 cartridge tape drive.
KFQSA	Q-bus DSSI bus storage adapter. This adapter allows up to seven DSSI storage devices to attach to the DSSI bus. (Six DSSI storage devices are allowed in a Dual-Host Configuration.)	TUK50	UNIBUS tape controller for the TK50 cartridge tape drive. One TUK50 tape controller is supported per system.
KLESI	Q-bus, UNIBUS, and VAXBI tape controller for the TU81-Plus, RV20, or RC25.	UDA50	UNIBUS MSCP disk controller. The UDA50 controller must have a minimum microcode version of REV 3. The UDA50 controller supports up to 4 of the following disk drives: RA60, RA80, RA81, and RA82.
KRQ50	Q-bus controller for the RRD40/RRD50 compact disk reader.	Controller Options Supported by Digital's Services Enterprise Integration Center (SEIC)	
KZQSA	Q-bus to SCSI bus adapter. This adapter allows up to 7 SCSI storage devices to attach to the SCSI bus.	TSV05	Q-bus tape controller for the TS05 magnetic tape drive.
LP11	UNIBUS parallel high-speed line printer controller for the LPxx printers.	TSU05	Unibus tape controller for the TS05 magnetic tape drive.
LPV11	Q-bus parallel high-speed line printer controller.	MASSBUS Adapter/Tape Subsystems	
RK711	UNIBUS disk controller for RK07 disk drives.	These include a MASSBUS adapter, a tape formatter, and a transport (a TU77 for the TxU77 subsystems, a TE16 transport for TxE16 subsystem, or a TU78 for the TEU78 subsystem).	
RL211	UNIBUS disk controller for the RL02 disk drive.	A maximum of three additional TU77 magnetic tape transports can be added to a TxU77 subsystem and a maximum of seven additional TE16 magnetic tape transports can be added to a TxE16 subsystem. Different magnetic tape transports cannot be mixed on the same tape subsystem.	
RQDXx	Q-bus disk controller for MicroVAX and VAX-station systems. There is an RQDX1, RQDX2, and an RQDX3 controller. The RQDXx disk controller supports as many as four disk units, with each RX50 diskette drive counting as two units. Due to controller limitations, the system supports a maximum of 4 devices; the number of RD/RX devices the system supports depends on the enclosure. The RQDX3 disk controller is required for the RD54 and the RX33 drives.	With disks and magnetic tape transports mixed on the same MASSBUS, the following rules apply:	
RX211	UNIBUS diskette controller for two RX02 drives. One RX211 diskette controller is supported per system.	<ul style="list-style-type: none"> Disks can be added to a magnetic tape subsystem to a maximum of seven additional disks per tape subsystem. Tapes cannot be added to a disk subsystem. 	
RUX50	UNIBUS diskette controller for RX50 drives. One RUX50 diskette controller is supported per system.	Asynchronous Terminal Controllers	
TM03	MASSBUS tape controller for the TE16 and TU77 magnetic tape drives.	CXA16	16 line serial terminal multiplexer (DEC-423), maximum baud rate supported: 38400. (No modem control) (Q-bus)
TM32	BI-bus 9 track tape controller only with large record support.	CXB16	16 line serial terminal multiplexer (RS422), maximum baud rate supported: 38400. (No modem control) (Q-bus)
TM78	MASSBUS tape controller for the TU78 magnetic tape drive.	CXY08	8 line serial terminal multiplexer (RS232), maximum baud rate supported: 19200. (Full modem control) (Q-bus)
TQK50	Q-bus tape controller for the TK50 cartridge tape drive.	DHB32	16 line asynchronous terminal controller for VAXBI, maximum baud rate supported: 19200. (VAXBI)
TQK70	Q-bus tape controller for the TK70 cartridge tape drive.		
TS11	UNIBUS tape controller for the TS11 magnetic tape drive.		
TBK50	BI-bus tape controller for the TK50 cartridge tape drive.		

DHF11	32 line asynchronous terminal controller (DEC 423), maximum baud rate supported: 19200. (No modem control) (Q-bus)
DHT32	8 line asynchronous terminal controller (DEC 423). (No modem control) (MicroVAX 2000)
DHQ11	8 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: 19200. (Full modem control) (Q-bus)
DHU11	16 line asynchronous terminal controller (RS-232-C), maximum baud rates supported: VMS 19200, DECnet-VAX 9600. (Full modem control) (UNIBUS)
DHV11	8 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rates supported: VMS 19200, DECnet-VAX 9600. (Full modem control) (Q-bus)
DMB32	8 line asynchronous terminal controller, maximum baud rates supported: VMS 19200, DECnet-VAX 9600. (Full modem control) (VAXBI)
DMF32	8 line asynchronous terminal controller, maximum baud rates supported: VMS supports 19200, DECnet-VAX supports 9600. (Full modem control on first 2 lines) (UNIBUS)
DMZ32	24 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rates supported: VMS 19200, DECnet-VAX 9600. (Modem support dependent on configuration) (UNIBUS)
DSH32	1 line synchronous (full modem control) and 8 line asynchronous (no modem control) communications controller for the MicroVAX 2000. DEC423 devices are supported. Maximum baud rates supported: VMS 19.2 KBPS (kilobits/second).
DZ11	8 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: 9600. (Partial modem control) (UNIBUS)
DZ32	8 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: 9600. (Partial modem control) (UNIBUS)
DZQ11	4 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: VMS supports 19200, DECnet-VAX supports 9600. (Partial modem control) (Q-bus)
DZV11	4 line asynchronous terminal controller (EIA RS-232-C or RS-423-A), maximum baud rate supported: VMS supports 19200, DECnet-VAX supports 9600. (Partial modem control) (Q-bus)

Integral asynchronous serial lines for the MicroVAX 2000 and the VAXstation 2000.

On the MicroVAX 2000, one line is the modem/data line and three are data-only lines. On the VAXstation 2000, the lines support keyboard, mouse, modem connection, and printer or plotter. DECnet-VAX supports all four asynchronous data/modem RS-232C serial lines up to 9.6 KBPS on the integral 4 line asynchronous controller for MicroVAX 2000.

Synchronous Controllers

The VAX Wide Area Network Device Drivers software product contains the synchronous device drivers and is required when using synchronous communication options. Refer to SPD 29.64.xx for more information.

DMB32	Point-to-point synchronous interface. (VAXBI)
DMC11	High-speed local point-to-point synchronous interface; retired device, no longer offered as an option. (UNIBUS)
DMF32	Point-to-point or multipoint synchronous interface. (UNIBUS)
DMP11	Point-to-point or multipoint synchronous interface; (UNIBUS) retired device, no longer offered as an option.
DMR11	Remote point-to-point synchronous interface; (UNIBUS) replaces DMC11.
DMV11	Point-to-point or multipoint synchronous interface. (Q-bus)
DPV11	Synchronous, 1 line, half or full-duplex point-to-point communication interface supporting DDCMP, HDLC, SDLC, or BISYNC protocols.
DSB32	Two line, multiple protocol, synchronous adapter. (VAXBI)
DSH32	1 line synchronous (full modem control) and 8 line asynchronous (no modem control) communications controller for the MicroVAX 2000. DEC423 devices are supported. Maximum baud rates supported: VMS 19.2 KBPS (kilobits/second). 9.6 KBPS for MicroVAX 2000, etc.
DST32	Synchronous single line support for DDCMP up to 9.6 KBPS, full duplex for MicroVAX 2000 systems. Concurrent use with the DHT32 is not supported.
DSV11	Synchronous, 2 line, half or full-duplex point-to-point communication interface supporting DDCMP (1 or 2 lines up to 64 KBPS).
DSF32	DEC WANcontroller 620 — Two line synchronous communications controller designed specifically for the VAXft 3000 processors, supporting DDCMP. DDCMP is supported at speeds up to 64 KBPS per line for a two-line operation.

Ethernet Options

DEUNA	Ethernet to UNIBUS controller.
DELUA	Ethernet to UNIBUS controller. The minimum revision level required is F1.
DEBNA	Ethernet to VAXBI communication controller.
DEBNI	Ethernet to VAXBI communication controller.
DEMFA	The DEMFA is a high performance network adapter that connects XMI systems to both Ethernet and IEEE FDDI (Fiber Distributed Data Interconnect) local area networks.
DEMNA	The DEMNA is a high performance network adapter that connects XMI systems to both the Ethernet and IEEE 802.3 local area networks.
DESVA	Ethernet controller interface.
DEQNA	Ethernet controller to Q-bus. The minimum revision level required is K3. All systems utilizing a DEQNA must operate with software data checking enabled. Since AUTOGEN will automatically set the correct parameter, no system management intervention is required. Not supported by VAXcluster software. Not supported for any interfaces except for access using QIO or ALTSTART interfaces.
DELQA	Ethernet controller to Q-bus. This is the replacement for DEQNA. The minimum revision level required is C3.
DESQA	Ethernet controller to Q-bus for S-BOX configurations.
KFE52	DSSI/Ethernet Adapter for the VAXft 3000. Minimum of two adapters per system providing redundant connection to the Ethernet and the DSSI buses.

CI Options

VAXcluster Software may support multiple CI adapters per system. Refer to the VAXcluster Software Product Description (SPD 29.78.xx) for the supported configurations.

CI750	CI Adapter for VAX-11/750 systems. (Minimum microcode version REV 8.7 is required.)
CI780	CI Adapter for VAX-11/780, VAX-11/785, VAX 8600, and VAX 8650 systems. (Minimum microcode version REV 8.7 is required.)
CIBCI	CI Adapter for VAXBI systems. (Minimum microcode version REV 8.7 is required.)
CIBCA-AA	Native CI Adapter for VAXBI systems. (Minimum microcode version REV 7.5 is required.)
CIBCA-BA	Native CI Adapter for VAXBI systems. (Minimum microcode version REV 5.2 is required.)
CIXCD-AA	Native CI Adapter for VAX 9xxx XMI systems. (Minimum microcode version REV 1.0 is required.)

CIXCD-AB Native CI Adapter for VAX 6xxx XMI systems. (Minimum microcode version REV 1.0 is required.)

Miscellaneous

CR11	Card reader. One CR11 card reader is supported per system. (UNIBUS)
DRV11-WA	General purpose DMA interface. (Q-bus)
DR11-W	General purpose high-speed DMA interface — one DR11-W interface supported per UNIBUS.
DR750	High performance general purpose interface for the VAX-11/750. One DR750 interface is supported per system. This device may not be used in conjunction with the CI750.
DR780	High performance general purpose interface for the VAX-11/780 and VAX-11/785. One DR780 interface is supported per system. On the VAX 8600 and VAX 8650 as many as four per system are permitted provided that the M8297-YA is used.
DSSI	Digital Storage Systems Interconnect.
DWBUA	XMI to UNIBUS adapter.
DWMBA	XMI to BI adapter; also the adapter used to connect the XMI to VAX expander cabinet.
DWMVA	XMI to VME adapter.
DW750	UNIBUS Adapter for second UNIBUS for the VAX-11/750 system.
DW780	UNIBUS Adapter for VAX-11/780, VAX 8600 and VAX 8650.
FP730	Floating Point Accelerator for the VAX-11/730 system.
FP750	Floating Point Accelerator for the VAX-11/750 system.
FP780	Floating Point Accelerator for the VAX-11/780 system.
FP785	Floating Point Accelerator for the VAX-11/785 system.
FP86-AA	Floating Point Accelerator for the VAX 8600 and VAX 8650 systems.
EV64A	Vector Processing option for the VAX 6000-400.
H7112	Memory battery back-up for VAX-11/750, VAX-11/780, VAX-11/785, VAX 8600, and VAX 8650 systems. This is required for power-fail/recovery.
KE780	G and H floating point microcode for the VAX-11/780 system.
KU780	User-writeable control store for the VAX-11/780 system.

MA780	Multiport shared memory. A multiple version VMS 4.7 and VMS 5.x-n VAXcluster system is not supported if the system is configured with MA780 memory.
RH750	MASSBUS adapter for the VAX-11/750 system.
RH780	MASSBUS controller for the VAX-11/780, VAX-11/785, VAX 8600, and VAX 8650 systems.
SBI	System Backplane Interconnect for the VAX-11/780, VAX-11/785, and I/O BUS for the VAX 8600 and VAX 8650 systems.
SCSI	Small Computer System Interconnect.
VS40X	4-plane graphics coprocessor.
WS01X	VAXstation 3100 SPX Graphics option.
InfoServer 100	InfoServer 100 is a stand-alone Ethernet-based virtual disk server. The server has locally attached SCSI removable CDROMs and SCSI disk storage. VMS V5.5 supports virtual disk reads. For other features, please refer to the InfoServer 100/150 Software Product Descriptions.

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Appendix C

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Journal of Child and Family Studies (JCF) is a refereed journal of applied research and theory in child and family intervention and prevention. It is published quarterly.

The journal publishes research reports, critical reviews, and theoretical articles on topics related to child and family intervention and prevention.

Child and family intervention and prevention research is concerned with the design and evaluation of interventions designed to reduce or eliminate child abuse and neglect, child and adolescent mental health problems, and other social problems. The journal also publishes research on the prevention of child abuse and neglect, child and adolescent mental health problems, and other social problems. The journal also publishes research on the prevention of child abuse and neglect, child and adolescent mental health problems, and other social problems.

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Software Warranty Addendum

TO SOFTWARE PRODUCT DESCRIPTION

SOFTWARE PRODUCTS

The software product is warranted to conform to the Software Product Description (SPD). This means that DIGITAL will remedy any nonconformance when it is reported to DIGITAL by the customer during the warranty period.

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Software-defined Networking: A Survey

YUHUA WANG, YUNHE ZHENG, AND JIANG XIAO

SOFTWARE-DEFINED

Networking (SDN) has been considered as a major paradigm shift in network architecture. It aims to separate the control plane from the data plane, which makes it easier to manage and program the network. SDN has been widely adopted in data centers and mobile networks.

Software-defined networking (SDN) is a paradigm that separates the control plane from the data plane. This allows for more efficient management and programmability of the network. SDN has been widely adopted in data centers and mobile networks.

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Network Function Virtualization

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Software Product Description

PRODUCT NAME: VAX RMS Journaling, Version 5.5

SPD 27.58.06

DESCRIPTION

VAX RMS Journaling helps maintain the data integrity of RMS files in the event of a number of failure scenarios. Journaling helps to protect RMS file data from becoming lost or inconsistent.

VAX RMS Journaling provides the following three methods of journaling:

- After-image (AI) journaling provides the ability to redo a series of modifications to a data file. This type of journaling helps recover lost or corrupted files. After-image recovery restores the contents of the file from the point of the latest backup copy of that file.
- Before-image (BI) journaling provides the ability to undo a series of modifications to a data file. This type of journaling allows a file to be returned to a previous known state. This is useful in the event that a file is updated with erroneous data.
- Recovery-unit journaling helps maintain transaction integrity, where a transaction consists of a group of related operations that must be "atomic." That is, either all of the operations complete in their entirety or none of the operations complete. This type of journaling helps prevent data from becoming inconsistent due to the incomplete execution of a transaction.

Journaling is applied on a file-by-file basis. A file can be marked for after-image, before-image, recovery-unit journaling, or any combination of these methods. Within a given application, any combination of journaling methods can be used.

VAX RMS Journaling stores the information necessary for data recovery in files known as journals. Multiple data files can use the same journal.

RMS Recovery-Unit Journaling and DECdtm Transactions

Transactions are defined and managed using the DECdtm transaction services available in VMS. An RMS recovery unit is a set of RMS record operations, performed in the context of a single process, that are part of transactions coordinated by DECdtm services. RMS recovery units are started automatically by RMS, and

RMS recovery units are committed or aborted along with the transaction of which they are a part.

VAX RMS Journaling functions as a participating resource manager through the utilization of DECdtm services. DECdtm services are implemented using a two-phase commit protocol as described in the VMS Operating System Software Product Description (SPD 25.01.xx). Recovery-unit journaling supports both a one-phase and a two-phase commit protocol.

Remote RMS files (files accessed by means of the DAP /FAL protocol) that are marked for recovery-unit journaling can be modified within a transaction, and will be included in the "atomic unit of work" defined by the transaction. Also, the modifications made to RMS files marked for recovery unit journaling can be combined with modifications made using any resource manager that supports DECdtm services into a single "atomic" transaction.

The Recovery Unit Facility (RUF) services have been superseded by DECdtm services. However, the RUF services are still supported and are transparently emulated using the DECdtm services. Existing applications written using the RUF services continue to work without recompilation or relinking.

Supported File Organizations

All RMS file organizations are supported by VAX RMS Journaling. Any sequential, relative, or Prolog 3 indexed file can use journaling. However, the following restrictions apply:

- Prolog 1 and Prolog 2 indexed files are not supported by VAX RMS Journaling.
- Sequential files are limited to a record size of 32,667 bytes.
- Files marked for recovery-unit journaling cannot be written with the DCL WRITE command.
- Stream files cannot be modified in shared mode in a recovery unit.
- Sequential files having VFC record format do not allow shared access for recovery-unit journaling.

When using recovery-unit journaling with shared fixed-length sequential files, any abort processing overwrites records added to the recovery unit with zero bytes (null characters). This occurs because the record cannot be deleted from the file.

All files that are marked for journaling must reside on Files-11 Structure Level 2 disks. All journals must also reside on a Files-11 Structure Level 2 disks. It is recommended that journals used for after-image journaling reside on a disk volume that is different from the disk volume where the data file that uses the journal resides. Journaling across a network or to a tape device is not supported.

Marking Files for Journaling

VAX RMS Journaling is enabled on a file-by-file basis. Files marked for after-image, before-image, and recovery-unit journaling are enabled by using qualifiers to the DCL command SET FILE. Any combination of qualifiers can be used with a particular SET FILE command or series of SET FILE commands. Files are unmarked for journaling using the SET NOFILE command.

The most recent SET FILE command for a given file overrides all previous SET FILE commands for that file.

Successful marking of an RMS file for journaling requires exclusive access to the file specified in the SET FILE command. Exclusive access means the RMS file being marked for journaling must be closed; that is, application programs accessing that file must be shut down before the file can be successfully marked for journaling.

No modifications to application programs are required for long-term (after-image or before-image) journaling. Once a file has been marked for long-term journaling, journal information will be written to the journal each time the file is modified. The file must have been opened subsequent to the issuance of the SET FILE command that marked the file for VAX RMS Journaling. All modifications to the file are recorded in the journal until the file is unmarked for journaling.

Modifications to application programs are required for recovery-unit journaling. At a minimum, the program must specify the start and end of a recovery unit, using the recovery unit system services. When a file is marked for recovery-unit journaling, all modifications to that file within an application must be within a recovery unit.

Journal File Maintenance

After-image and before-image journals require periodic maintenance. Because journal files can expand indefinitely and a journal must reside on a single volume set, occasional remarking of a file for journaling and all of the associated operations is required. This implies that applications accessing RMS data files marked for

after-image or before-image, or both, journaling must be stopped periodically for journal maintenance operations.

Recovering Data — Long-Term Journaling

In the case of long-term (either after-image or before-image) journaling, data recovery is done using the RMS Recovery Utility. Recovery is on a file-by-file basis and must be explicitly requested; it is not done automatically. The RMS Recovery Utility is invoked at DCL level to either roll forward or roll back changes to the file. The Recovery Utility requires exclusive access to the file being recovered. Changes can be rolled forward or rolled backward until a time specified by the user.

To roll forward a file and redo changes, a VMS backup copy of the file must be on disk. This backup copy must have been made after the file was marked for after-image journaling.

Recovering Data — Recovery-Unit Journaling

No user intervention is required to roll back a recovery unit that is incomplete. The rollback of an incomplete transaction is started and completed automatically the next time the user accesses the file.

Interaction with Backup

To recover data using after-image journaling, a backup copy of the file must be available. This copy must be made with the Backup Utility (BACKUP); a copy of the file made with the COPY or CONVERT command cannot be used. A backup copy of the file must be made after the SET FILE/AI_JOURNAL command is issued but before the file is opened for update. BACKUP requires exclusive access to files being backed up. No user or application program can access the file until BACKUP is finished.

The use of BACKUP/RECORD is recommended. If the file is then rolled forward, the modifications that have been made since the most recent backup are applied.

If a backup copy of a file is rolled forward with the RMS Recovery Utility, users must remark the file for after-image journaling with the SET FILE/AI_JOURNAL command. A backup copy of that file must be made after it has been marked for after-image journaling and before application updates are allowed.

A backup copy of the file must be remarked for journaling if it is to be used in place of the original file.

Interaction with VAX Volume Shadowing

VAX Volume Shadowing can be used in conjunction with after-image journaling. After-image journaling helps recover data in the following cases not addressed by VAX Volume Shadowing:

- Mistaken deletion of a file by a system user or operator
- Corruption of the file system pointers
- RMS file corruption due to a software error or incomplete bucket write operations to an indexed file

Failures Not Addressed by RMS Recovery-Unit Journaling

Recovery-unit journaling alone does not provide recovery in cases when a multi-block bucket write operation to an indexed file is in progress, leaving the bucket in the indexed file in a corrupt state. Use after-image journaling in conjunction with recovery-unit journaling to recover from the following failed multi-block bucket write operations:

- Failure of the VAX host during a multi-block write operation, such as a VMS crash, halt, power failure, or system shutdown.
- Permanent loss of path to the disk during a multi-block write operation.
- Cancellation of a multi-block write operation in progress. This occurs only in disks using DU-DRIVER. Other disk drivers ignore the cancellation of I/O and are not affected.

HARDWARE REQUIREMENTS

Refer to the VMS Operating System Software Product Description (SPD 25.01.xx) for hardware requirements and supported processors.

OPTIONAL HARDWARE

None

CLUSTER ENVIRONMENT

This layered product is fully supported without restrictions when installed on any valid and licensed VAXcluster* configuration. The **HARDWARE REQUIREMENTS** sections of this product's Software Product Description and the VMS Operating System Software Product Description (SPD 25.01.xx) list any special hardware required by this product.

* VAXcluster configurations are fully described in the VAXcluster Software Product Description (SPD 29.78.xx) and include CI, Ethernet, and Mixed Interconnect configurations.

SOFTWARE REQUIREMENTS

VMS Operating System

VMS Tailoring

For VMS V5.x, the following VMS class is required for full functionality of this system integrated product:

- VMS Required Saveset

For more information about VMS classes and tailoring, refer to the VMS Operating System Software Product Description (SPD 25.01.xx).

OPTIONAL SOFTWARE

None

GROWTH CONSIDERATIONS

The minimum hardware/software requirements for any future version of this product may be different from the requirements for the current version.

ORDERING INFORMATION

Software Licenses: QL-VDVA*-**

Software Documentation: QA-VDVAA-GZ

Software Product Services: QT-VDVA*-**

- * Denotes variant fields. For additional information on available licenses, services, and media, refer to the appropriate price book.

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Software Product Description

PRODUCT NAME: VAXcluster Software, Version 5.5

SPD 29.78.05

DESCRIPTION

VAXcluster Software is a VMS System Integrated Product (SIP). It provides a highly integrated VMS computing environment distributed over multiple VAX, VAX Workstation, and MicroVAX CPUs. This environment is called a VAXcluster system.

CPUs in a VAXcluster system can share processing, mass storage, and other resources under a single VMS security and management domain. Within this highly integrated environment, CPUs retain their independence because they use local, memory-resident copies of the VMS Operating System. Thus, VAXcluster CPUs can boot and shut down independently while benefiting from common resources.

Applications running on one or more CPUs in a VAXcluster system access shared resources in a coordinated manner. VAXcluster Software components synchronize access to shared resources, preventing multiple processes on any CPU in the VAXcluster from interfering with each other when updating data. This coordination ensures data integrity during multiple concurrent update transactions.

Because resources are shared, VAXcluster systems offer higher availability than standalone CPUs. Properly configured VAXcluster systems can withstand the shut down or failure of various components. For example, if one CPU in a VAXcluster is shut down, users can log on to another CPU to create a new process and continue working; since mass storage is shared VAXcluster-wide, the new process is able to access the original data. Applications can be designed to survive these events automatically.

All VAXcluster systems have the following software features in common:

- Shared file system — The VMS Operating System and VAXcluster software allows all CPUs to share read and write access to disk files in a fully coordinated environment. Application programs can specify the level of VAXcluster-wide file sharing that is

required; access is then coordinated by the VMS Extended QIO Processor (XQP) and Record Management Services (RMS).

- Shared batch and print queues are accessible from any CPU in the VAXcluster system. The VMS queue manager controls VAXcluster-wide batch and print queues, which can be accessed by any CPU. Batch jobs submitted to VAXcluster-wide queues are routed to any available CPU so the batch load is shared.
- The VMS Lock Manager System Services operate in a VAXcluster-wide manner. These services enable reliable coordinated access to any resource and provide signaling mechanisms, at the system and process level, across the whole VAXcluster system.
- All disks and TMSCP tapes in a VAXcluster system can be made accessible to all CPUs.
- Process information and control services are available VAXcluster-wide to application programs and system utilities.
- An automated configuration command procedure assists in adding and removing CPUs and in modifying their configuration characteristics.
- The dynamic Show Cluster Utility displays the status of VAXcluster hardware components and communication links.
- Standard VMS system and security features work in a VAXcluster-wide manner such that the entire VAXcluster system operates as a single security domain.
- The VAXcluster software dynamically balances the interconnect I/O load in VAXcluster configurations that include multiple interconnects.
- Multiple VAXcluster systems can be configured on a single Local Area Network (LAN).

Definitions:

The following terms are used throughout this SPD:

- CPU (Central Processing Unit) — A VAX-family computer that includes one or more processors. A CPU operates as a VAXcluster node. A VAXcluster node can be referred to as VAXcluster member.

- Disk server — A CPU that makes disks to which it has direct access available to other CPUs in the VAXcluster system, using the VMS MSCP Server.
- Maintenance Operations Protocol (MOP) server — A CPU that services satellite boot requests, using DECnet-VAX software, to provide the initial Local Area Network (LAN) down-line load sequence of the VMS Operating System and VAXcluster software. At the end of the initial down-line load sequence, the satellite uses a disk server to perform the remainder of the VMS booting process.
- Satellite — A CPU that is booted over a LAN using a MOP server and disk server.
- Tape server — A CPU that makes TMSCP tapes to which it has direct access available to other CPUs in the VAXcluster system, using the VMS TMSCP Server.
- Mixed Interconnect VAXcluster System — A VAXcluster system that uses more than one type of interconnect for VAXcluster communication.

Interconnects:

VAXcluster systems are configured by connecting multiple CPUs with a communication media, referred to as an interconnect. VAXcluster nodes communicate with each other using the most appropriate interconnect available. Whenever possible, in the event of interconnect failure, VAXcluster software will automatically use an alternate interconnect. VAXcluster Software supports any combination of the following interconnects:

- Computer Interconnect (CI)
- Ethernet (NI)
- Digital Storage System Interconnect (DSSI)*
- Fiber Distributed Data Interface (FDDI)

Ethernet and FDDI are industry-standard general purpose communications interconnects that can be used to implement a Local Area Network (LAN). Except where noted, VAXcluster support for both of these LAN types is identical.

Configuration Rules:

The following configuration rules apply to VAXcluster systems:

- The maximum number of CPUs supported in a VAXcluster system is 96.
- Every VAXcluster node must have a direct communication path to every other VAXcluster node via any of the supported interconnects.

* The DSSI is not used as a VAXcluster interconnect when accessed via a KFQSA Q-bus adapter. The KFQSA adapter only supports access to DSSI mass storage devices.

- VAX 11/7xx, 6000, 8xxx, and 9000-series CPUs require a system disk that is accessed via a local controller or through a local CI or DSSI connection. VAXcluster satellite booting is not supported for these systems.
- A Star Coupler is a common connection point for CI connected CPUs and HSC subsystems. All CPUs connected to a Star Coupler must be configured as VAXcluster members. A VAXcluster system can include any number of Star Couplers. The number of CI adapters supported by different CPUs can be found in Table 2 in this SPD; the number of Star Couplers that a CPU can be connected to is limited by the number of adapters it is configured with.
- The maximum number of CPUs that can be connected to a Star Coupler is 16, regardless of Star Coupler size.
- The RA-series disks and TA-series tapes can be dual pathed between pairs of HSC subsystems on the same Star Coupler, or between two local controllers. Such dual pathing provides enhanced data availability using a VMS automatic recovery capability called failover. Failover is the ability to use an alternate hardware path from a CPU to a storage device when a failure occurs on the current path. The failover process is transparent to applications. Dual pathing between an HSC and a local controller is not permitted. When two local controllers are used for dual pathing, each controller must be located on a separate CPU.
- When multiple CPUs are connected to a common DSSI they must all be configured as VAXcluster members. Since the KFQSA Q-bus-to-DSSI adapter does not support VAXcluster communication to other CPUs on the DSSI, CPUs using this adapter must include another interconnect for VAXcluster communication.
- VAX 6000-series CPUs can be connected to a DSSI bus using the KFMSA XMI-DSSI adapter. Any mix of VAX 6000-series and VAX 4000-series systems (excluding the VAX 4000 Model 200) can be configured on a common DSSI bus, up to a maximum of three CPUs.
- A maximum of three VAX 4000 series, Q-bus-based MicroVAX 3000 series, and MicroVAX II systems can be configured on a common DSSI bus. In triple CPU configurations, the middle CPU must be a VAX 4000 Model 300, or higher, system.
- VAXcluster systems support 4 LAN adapters per CPU for VAXcluster communications. LAN segments can be bridged to form an extended LAN.
- CPUs that use an Ethernet for VAXcluster communications can concurrently use it for other network protocols that conform to the applicable Ethernet stan-

dards, such as Ethernet V2.0, IEEE 802.2, and IEEE 802.3.

- CPUs that use an FDDI for VAXcluster communications can concurrently use it for other network protocols that conform to the applicable FDDI standards, such as ANSI X3.139-1987, ANSI X3.148-1988, and ANSI X3.166-1990
- All LAN bridges must provide a low-latency data path, with approximately 10 megabits per second throughput for Ethernet and 100 megabits per second throughput for FDDI. Translating bridges must be used when connecting VAXcluster nodes on an Ethernet to those on an FDDI.
- The maximum number of VAXcluster members that can be directly connected to the FDDI, via the DEC FDDIcontroller 400 (DEMFA), is 16.
- A DECnet-VAX communication path must exist between all nodes in a VAXcluster system.
- A single time zone setting must be used by all CPUs in a VAXcluster system.
- A VAXcluster system can be configured with a maximum of one Quorum Disk. A Quorum Disk cannot be a member of a shadow, volume, or stripe set.

Recommendations:

The optimal VAXcluster system configuration for any computing environment is based on requirements of cost, functionality, performance, capacity, and availability. Factors that impact these requirements include:

- Applications in use
- Number of users
- Number and model of CPUs
- Interconnects and adapter types
- Disk and tape I/O capacity and access time
- Number of disks and tapes being served
- Interconnect utilization

Digital recommends VAXcluster system configurations based on its experience with the VAXcluster Software Product. The customer should evaluate specific application dependencies and performance requirements to determine an appropriate configuration for the desired computing environment.

When planning a VAXcluster system, consider the following recommendations:

- While VAXcluster systems can include any number of system disks, performance and disk space should be considered in determining their number and location. It is important to recognize that system management

efforts increase in proportion to the number of system disks.

- VAXcluster CPUs should be configured using interconnects that provide appropriate performance for the required system usage. In general, use the highest performance interconnect possible. CI, DSSI, and FDDI are the preferred interconnects between powerful VAX CPUs.
- Data availability and I/O performance is enhanced when multiple VAXcluster nodes have direct access to shared storage; whenever possible, configure systems to allow direct access to shared storage in favor of VMS MSCP Served access. Multi-access DSSI- and HSC-based storage provide higher data availability and I/O performance than singly accessed, local controller-based storage. Additionally, dual pathing of DSA disks between local or HSC storage controllers enhances data availability in the event of controller failure.
- VAXcluster systems can provide enhanced availability by utilizing redundant components. For example, additional CPUs, storage controllers, and disks and tapes can be configured. Extra peripheral options such as printers and terminals can be included to further enhance availability. Multiple instances of all the VAXcluster interconnects (CI, DSSI, Ethernet, and FDDI) are supported.
- If possible, LAN-based and Mixed Interconnect VAXcluster systems should include multiple MOP and disk servers to enhance availability. When a server fails in configurations that include multiple servers, satellite access to disks fails over to another server. Disk servers should be the most powerful CPUs in the VAXcluster and should use the highest bandwidth LAN adapters available.
- When a LAN-based VAXcluster system is configured with high performance nodes, multiple LAN adapters and interconnects can be used to increase total communication bandwidth.
- Maintenance of complex LAN-based VAXcluster configurations can be simplified with the aid of the VMS LAVC\$FAILURE_ANALYSIS program, which is available in the SYS\$EXAMPLES directory.
- VAXclusters are sensitive to the LAN traffic levels. The average LAN segment utilization should not exceed 60 percent for any 10 second interval. Nodes can leave the cluster if they cannot properly exchange the HELLO messages every three seconds. LAN bridges can be used to localize VAXcluster system traffic should the overall level of network traffic be a concern. Also, it is possible for VAXcluster nodes to exist on both sides of a LAN bridge.

- The performance of an FDDI LAN will vary with each configuration. When an FDDI is used for VAXcluster communications, the ring latency when the FDDI ring is idle should not exceed 400 microseconds.
- When under heavy network load, bridges are subject to packet loss and retransmission, due to congestion. This is especially true of Ethernet to FDDI bridges. In a VAXcluster environment, heavy network loads can result when many satellite nodes are booted simultaneously. It may be necessary to minimize simultaneous booting, or limit the number of nodes that utilize these LAN bridges.
- The VAXcluster Multi-Datacenter Facility is specifically designed to allow successful implementation and management of disaster-tolerant configurations and to deliver predictable recovery from site failures.

For more information, refer to the VAXcluster Multi-Datacenter Facility Software Product Description (SPD 35.05.xx).

- The optional VMS Volume Shadowing System Integrated Product provides the following advantages:
 - Enhanced data availability in the event of disk failure
 - Enhanced read performance with multiple system and data disks

For more information, refer to the VMS Volume Shadowing Software Product Description (SPD 27.29.xx.).

HARDWARE SUPPORT

Supported CPUs:

Any VAX, VAXstation, or MicroVAX CPU, as documented in the VMS SPD, can be used in a VAXcluster, with the exception of the VAX-11/730, VAX-11/782, and VAXstation 8000 CPUs.

Any CPU can be configured as a VAXcluster satellite node, with the exception of VAX 11/7xx, 6000, 8xxx, and 9000-series CPUs.

For MicroVAX 3500 and MicroVAX 3600 CPUs configured with KFQSA DSSI adapters, the console ROMs must be at Revision Level V5.1, at a minimum.

Supported CI Adapters:

VAXcluster nodes can be configured with multiple CI adapters. Table 1 shows the types of adapters that are supported by each CPU. There can only be one type of adapter configured on a CPU; the maximum quantity of each type is noted in the table. The CI adapters in a CPU can connect to the same, or different, Star Couplers.

Note: The CIBCA-A and CIBCA-B are different.

Table 1

CPU Type	CI750	CI780	CIBCI	CIBCA-A	CIBCA-B	CIXCD
11/750	1	-	-	-	-	-
11/760	-	1	-	-	-	-
11/785	-	1	-	-	-	-
6000-xxx	-	-	-	1	4	4
82xx	-	-	1	1	1	-
83xx	-	-	1	1	1	-
85xx	-	-	1	1	2	-
86xx	-	2	-	-	-	-
8700	-	-	1	1	2	-
88xx	-	-	1	1	2	-
9000-xxx	-	-	-	-	-	6

Supported LAN Adapters:

Table 2 shows the types of Local Area Network (LAN) adapters supported by VAXcluster software.

Table 2

Bus	Ethernet	FDDI
XMI	DEMNA	DEMFA
BI	DEBNI,DEBNA	
Q-bus	DELQA,DESQA	
Q-bus	DEQTA (DELQA-YM)	
UNIBUS	DEUNA,DELUA	
Integral	LANCE,SGEC	

Supported Peripheral Options:

VAXcluster systems can use all peripheral options supported by the VMS SPD. Refer to the VMS Software Product Description (SPD 25.01.xx) for further information.

Memory Requirements:

All VAXcluster CPUs must have a minimum of 4 megabytes of physical memory.

Star Coupler Expander:

A Computer Interconnect Star Coupler Expander (CISCE) can be added to any Star Coupler to increase its connection capacity to 32 ports. The maximum number of CPUs that can be connected to a Star Coupler is 16, regardless of size.

HSC Subsystems:

VAXcluster software supports all models of the HSC family of intelligent mass storage controllers. These controllers include many features:

- The ability to provide high data throughput and I/O rates
- Implementation of many mass storage performance optimization techniques
- Multi-CPU access to disk and tape units
- The ability to configure multiple disk and tape units
- Optional HSC-based disk caching (for the HSC60 and HSC90)
- HSC resident maintenance and backup facilities

The following rules apply for HSC subsystems:

- HSC Software, Version 6.0, at a minimum, is required for the HSC40, HSC60, HSC70, and HSC90. HSC Software, Version 4.1, at a minimum, is required for the HSC50.
- Each HSC40 supports a maximum of 12 ports.
- Each HSC50 supports a maximum of 24 ports.
- Each HSC60 supports a maximum of 20 ports.
- Each HSC70 supports a maximum of 32 ports.
- Each HSC90 supports a maximum of 48 ports.
- All ports can be used for disk storage. The maximum number of ports that can be used for tapes is 24 for the HSC70 and HSC90, and 12 for the HSC40, HSC50, and HSC60.

SOFTWARE REQUIREMENTS

- VMS Operating System

VAXcluster Software, Version 5.5 is a VMS System Integrated Product that requires VMS, Version 5.5.

Refer to the VMS Software Product Description (SPD 25.01.xx) for further information.

VMS, Version 5.4, and all its sub-versions (for example V5.4-1, and V5.4-2), can coexist in a VAXcluster with VMS, Version 5.5 (and all its sub-versions). Only one version of VMS can exist on each system disk. In configurations with multiple system disks, a rolling upgrade can be performed so that continuous VAXcluster system operation is maintained during the upgrade process. During a rolling upgrade, a separate system disk is required for each version. Rolling upgrades occur in a series of phases during which all VAXcluster nodes are brought up to the latest VMS version.

During a rolling upgrade from Version 5.4 to Version 5.5, V5.4 Batch and Print functionality is maintained. Once the VAXcluster system is fully upgraded to Version 5.5, the new V5.5 Batch and Print functionality becomes available. Once the new V5.5 Batch and Print facility is operational, booting V5.4 CPUs into the VAXcluster system is only permitted if they do not use any Batch and Print operations (i.e., START /QUEUE/MANAGER). Coexistence of the V5.4 and V5.5 Batch and Print facilities is not supported.

Digital recommends that all VAX systems in a VAXcluster run the latest version of VMS.

- DECnet-VAX Software

All VAXcluster CPUs require either an End Node or Full Function DECnet-VAX license.

Refer to the DECnet-VAX Software Product Description (SPD 25.03.xx) for further information.

OPTIONAL SOFTWARE

For information on VAXcluster support for optional software products, refer to the *VAXcluster Support* section of the Software Product Description (SPD) documents for those products.

Optional products that are particularly useful in VAXcluster systems include:

- VMS Volume Shadowing (SPD 27.29.xx)
- VAX Performance Advisor (SPD 27.71.xx)
- VAXcluster Console System (SPD 27.46.xx)
- VAXcluster Multi-Datacenter Facility (SPD 35.05.xx)
- VAX Disk Striping (SPD 31.66.xx)

GROWTH CONSIDERATIONS

The minimum hardware/software requirements for any future version of this product may be different from the requirements for the current version.

ORDERING INFORMATION

Software Licenses: QL-VBRA*-AA

Software Product Services: QT-VBRA*--**

- * Denotes variant fields. For additional information on available licenses, services, and media, refer to the appropriate price book.

The above information is valid at time of release. Please contact your local Digital office for the most up-to-date information.

SOFTWARE LICENSING

A VAXcluster Software license is required for each CPU in a VAXcluster system.

This software is furnished under the licensing provisions of Digital Equipment Corporation's Standard Terms and Conditions. For more information about Digital's licensing terms and policies, contact your local Digital office.

A VAXcluster Multi-Datacenter Facility license is required when using VAXcluster software for implementing disaster tolerance. Disaster tolerance is the ability to recover from major site failure within a brief recovery period when using a single VAXcluster system that spans multiple buildings.

License Management Facility Support:

The VAXcluster Software product supports the VMS License Management Facility (LMF).

License units for this product are allocated on an Unlimited System Use basis.

For more information about the License Management Facility, refer to the VMS Operating System Software Product Description (SPD 25.01.xx) or the *License Management Facility Manual* of the VMS Operating System documentation set.

For more information about Digital's licensing terms and policies, contact your local Digital office.

SOFTWARE PRODUCT SERVICES

A variety of service options are available from Digital. For more information, contact your local Digital office.

SOFTWARE WARRANTY

Warranty for this software product is provided by Digital with the purchase of a license for the product as defined in the Software Warranty Addendum of this SPD.

TM The DIGITAL Logo, BI, CI, DECnet-VAX, DELUA, DE-UNA, HSC, HSC40, HSC50, HSC60, HSC70, HSC90, MicroVAX, Q-bus, RA, TA, UNIBUS, VAX, VAXstation, VAXcluster, VMS, and XMI are trademarks of Digital Equipment Corporation.

NOTES

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Software Product Description

PRODUCT NAME: DECnet-VAX, Version 5.5

SPD 25.03.30

DESCRIPTION

DECnet-VAX allows a suitably configured VMS system to participate as a routing or end node in DECnet computer networks. With proper network planning, DECnet-VAX, Version 5.5 networks can contain up to 1,023 nodes per network area and up to 63 areas per network. DECnet-VAX interfaces are standard components of VMS for use on a local standalone system.

DECnet-VAX end node and full function products are licensed separately for VMS. The DECnet-VAX License Product Authorization Key (PAK), when registered on a VMS system, enables communication between different networked systems that use the same protocols.

DECnet-VAX is a Phase IV network product and is warranted only for use with Phase III and Phase IV products supported by Digital Equipment Corporation.

DECnet-VAX offers task-to-task communications, file management, downline system and task loading, network command terminals, and network resource sharing capabilities using the Digital Network Architecture (DNA) protocols. DECnet-VAX communicates with adjacent and non-adjacent Phase III and Phase IV nodes (adjacent nodes are connected by a single communications line).

VMS programs written in VAX MACRO and native mode high-level languages can use DECnet-VAX capabilities, but programs executing in PDP-11 compatibility mode cannot use DECnet-VAX.

The network functions available to a DECnet-VAX user depend, in part, on the configuration of the rest of the network. Each DECnet product offers its own subset of Digital Network Architecture (DNA) functions and its own set of features to the user. Networks consisting entirely of DECnet-VAX Phase IV nodes have all the functions described in this Software Product Description (SPD). Networks that combine different DECnet implementations may limit the functions available to the DECnet-VAX user on non-DECnet-VAX nodes since other DECnet implementations may not implement certain functions. Similarly, a user of another

DECnet implementation may not be able to access all DECnet-VAX functions.

The functions available to users on mixed networks can be determined by a comparison of the SPDs for the appropriate DECnet products.

Routing

A Full Function DECnet-VAX License PAK must be registered on a node in order for that node to operate as a routing node. For a node to operate as an end node, either the Full Function or the End Node DECnet-VAX License PAK must be registered on that node. Full Function DECnet-VAX software allows a node to be set up as either a routing node or as an end node.

A DECnet-VAX node must function as a routing node whenever multiple circuits are used by that node. Routing nodes maintain information on the paths to other nodes in the network. DECnet-VAX end nodes provide all the capabilities of DECnet-VAX routing nodes with the exception that end nodes cannot route messages on behalf of other nodes in the network. Since end nodes do not route messages, they do not need to maintain routing information. Consequently, end nodes initiate less overhead message traffic than routing nodes and, therefore, consume less processing power than routing nodes.

Adaptive Routing is the mechanism that routing nodes use to "adapt" or choose other physical paths if the physical paths the routing nodes are using fail or change line cost.

In addition to adaptive routing, which all DECnet Phase IV implementations use, DECnet-VAX supports area routing. Area routing is a method by which DECnet can send and route messages between the nodes in different areas of the network. Up to 63 areas with up to 1,023 nodes per area are allowed. The network manager has the option of separating a network into areas. Area-based DECnet networks are hierarchical networks and some restrictions apply to communications from nodes in one area to nodes in another area. However, it is not required that all nodes in the network be DECnet-VAX or even Phase IV nodes. Proper network

planning is essential when using area routing or configuring large networks. Valid topologies are the responsibility of the customer.

Note: Only 32 routers are supported on an extended LAN.

A DECnet-VAX node has the ability to communicate with a remote node over multiple circuits simultaneously, as long as those circuits are all of equal cost AND provide the lowest cost path. DECnet-VAX routing nodes will split transmission of a packet load to a destination node via multiple paths if those paths are of equal lowest cost. This capability is called Equal Cost Path Splitting. This feature can increase throughput of data by using all the best available paths. In order to take full advantage of this capability, all intermediate routing nodes should also support this feature and all destination nodes must support out-of-order packet caching.

Standard DECnet-VAX Capabilities

Task-to-Task Communication

For most applications, task-to-task communication can be programmed in a transparent manner where the remote task is treated as a full duplex, record-oriented device. Transparent operation is provided via the following interfaces: System Service calls, RMS calls (OPEN, GET, PUT, and CLOSE) and high-level language I/O statements (which are mapped to RMS calls). A non-transparent mode of task-to-task communication is offered by means of the System Service interface that extends the capabilities provided by the transparent mode. These capabilities include support for interrupt messages and multiple inbound connect requests.

Using DECnet-VAX, a VMS program written in VAX MACRO or a native mode high-level language can exchange messages with other user programs. The two user programs can be on the same node, on adjacent Phase III or Phase IV nodes, or on any two non-adjacent Phase III or Phase IV nodes in the same network connected by Phase III or Phase IV routing nodes. DECnet-VAX imposes no special data formatting requirements on the user.

Network Resource Access

File Access — File access is supported to and from remote DECnet systems transparent to VAX MACRO and native mode high-level language programs using RMS. User programs can sequentially read, create, and delete files on a remote node.

Record Access — User programs can perform record level operations such as GET, PUT, UPDATE, DELETE, FIND, and REWIND to access and modify files residing on a remote VMS node. In addition to sequential access to a file, several other access methods are supported

through RMS using DECnet-VAX. These methods include random access by relative record number, random access by key value, random access by Record File Address (RFA), and block I/O access by virtual block number.

Proxy Access

Remote users can have access to up to 15 proxy accounts on a specific remote system. One proxy account should be designated as the default proxy account on the remote system.

Command Language File Management

Most VMS Digital Command Language (DCL) commands can be used to perform network file operations. These commands include: ANALYZE, APPEND, BACKUP, CLOSE, CONVERT, COPY, CREATE, DELETE, DIFFERENCES, DIRECTORY, DUMP, OPEN, PRINT, PURGE, READ, SEARCH, SUBMIT, TYPE, and WRITE. The operation of these commands is transparent except for commands that invoke processing on a specific system (i.e., SUBMIT/REMOTE and PRINT/REMOTE). Only a node name added to a file specification is required to invoke the network capabilities via one of these commands.

Using the COPY command, a user can transfer sequential, relative, and indexed-sequential (ISAM) files between DECnet nodes that support compatible file structures and record formats. Sequential or relative files with fixed length, variable length, or variable length with fixed control field records can be transferred between two VMS systems. Similarly, multi-keyed indexed files with variable or fixed length records are supported.

The SUBMIT command allows command files residing on a remote node to be submitted for execution at the remote node. The command file must be in the format expected by the node responsible for execution. Conversely, DECnet-VAX allows VMS command files to be received from other systems and executed.

A new DCL command, EXCHANGE-NETWORK, which allows for the transfer of files to or from heterogeneous systems, is now available. This new command gives users the option to transfer file types between MS-DOS® or ULTRIX systems and VMS systems regardless of record semantics. Unlike the COPY command, which preserves file and record organization during a file transfer, this command enables the user to modify file and record attributes during file transfer.

Downline System Loading

DECnet-VAX allows for the loading of an unattended system using the services provided by the Maintenance Operations Module (MOM). MOM provides a set of maintenance operations over various types of circuits by using the Maintenance Operations Protocol (MOP).

A loadable system is a system that has a load device enabled for MOP service functions and for which a properly formatted load file is supplied. Downline loading involves transferring a copy of the properly formatted load file image of a remote node's operating system from a VMS node to the unattended target node. For example, DECnet-VAX permits the user to load an RSX-11S Operating System file image from the VMS node downline to the target node. Load requests can come from the local DECnet-VAX operator or from the target node. Downline Loading is supported for Digital server products. However, this facility is not supported over asynchronous DECnet-VAX connections.

Downline Task Loading

Initial task images for loadable systems can be stored on VMS file system devices and loaded into remote nodes. Programs already executing on loadable RSX-11S systems can be checkpointed to the host VMS file system and later restored to main memory in the RSX-11S node running DECnet-RSX. Overlays for RSX-11S tasks can also be stored on VMS file system devices. These features simplify the operation of network systems that do not have mass storage devices.

This facility is not supported over asynchronous DECnet-VAX connections.

Upline Dumping

Memory images of adjacent RSX-11S nodes connected by DECnet can be written or dumped into a file on a VMS system. This facility helps a programmer understand what can cause the RSX-11S system to crash. This facility is also supported for Digital server products.

This facility is not supported over asynchronous DECnet-VAX connections.

Network Command Terminal

The DCL command, SET HOST, allows a terminal user on one DECnet-VAX node to establish a logical connection to another DECnet-VAX node or other types of DECnet nodes that use the Heterogeneous Command Terminal Protocol (consult the appropriate SPDs). This connection makes the terminal appear physically connected to the remote system and the operator can use all the standard system and network utilities supported by that remote node. This capability is particularly useful for doing remote program development and allows the terminal users on smaller application-oriented systems to use the resources of larger development-oriented systems.

VMS MAIL Utility

VMS MAIL allows transmission of text messages between users of a stand-alone VAX system. The DECnet-VAX software allows users to send and receive VMS MAIL to or from users of other VMS systems that operate within the same DECnet network.

VMS PHONE Utility

The VMS PHONE Utility allows users to send and receive data interactively from one user's terminal to another user's terminal. DECnet-VAX increases the scope of VMS PHONE to allow active users on different VMS systems in the same network to exchange information.

VAXcluster Alias

DECnet-VAX supports the ability to access some or all nodes in a VAXcluster using a separate alias node address, while retaining the ability to address each node in the cluster individually. Not all network objects may be accessed using this mechanism. More than 64 nodes can operate within a cluster, but the maximum number of nodes that are allowed to participate in the VAXcluster Alias is 64. Refer to the VAXcluster Software Product Description (SPD 29.78.xx) for relevant restrictions.

At least one node in the VAXcluster must be configured as a router in order to use this feature.

Network Management

The Network Control Program (NCP) performs three primary functions: displaying statistical and error information, controlling network components, and testing network operation. These functions can be performed locally or executed at remote Phase III or Phase IV nodes that support these functions. The NCP facility allows for planning, building, tuning, and controlling DECnet networks. NCP can be used to create and manage networks including local node operation, remote node operation, circuits, lines, and objects.

An operator can display the status of DECnet activity at any Phase III or Phase IV node in the network. The user can choose to display statistics related to the node itself or the communication lines attached to that node, including traffic and error data. The local operator can also perform many network control functions such as starting and stopping lines, activating the local node, and downline loading systems.

DECnet-VAX provides network event logging to a terminal device or disk file. Any logged event can be used to monitor, diagnose, and tune a network. The NCP utility can be used to enable and disable the event logging facility.

NCP can also be used to test components of the network. NCP enables transmission and reception of test messages over individual lines either between nodes or through other controller loopback arrangements. The messages can then be compared for possible errors. NCP allows the performance of a logical series of tests that will aid in isolating network problems.

Integrated Interfaces

DECnet-VAX interfaces are standard parts of the VMS Operating System for use on local, standalone systems. Users can develop programs and procedures based upon these interfaces for such functions as file access and task-to-task communication on individual systems. Since the DECnet-VAX interfaces stay the same, the programs and procedures developed on an individual system can be used in a network environment without being modified.

Communications Options

DECnet-VAX uses synchronous, asynchronous, Ethernet, FDDI, 802.5/Token Ring, and CI communications controllers to interface with other network nodes. Synchronous controllers use DDCMP, either when directly connected or when connected via modems, to provide full or half duplex communications over point-to-point lines, or full duplex over multipoint lines. Asynchronous controllers use DDCMP, either when directly connected or when connected via modems, to provide only full duplex communications over point-to-point lines.

Note: Error Correcting and data suppression modems are not supported. Refer to the *HARDWARE REQUIREMENTS* section for a short description of controllers.

Asynchronous lines are supported only to other systems running DECnet-VAX, DECnet-RSX, PRO/DECnet, DECnet-Rainbow, DECnet-VAXmate, and DECnet-DOS.

DDCMP operation is not supported in cases where an asynchronous physical communication line is emulated by lower level protocols or communication subsystems. Examples of this include X.29 virtual terminals, asynchronous connections as emulated by terminal servers, and connections via data switches.

The Ethernet, FDDI, and 802.5/Token Ring controllers allow DECnet-VAX to use these LAN technologies as its datalink transmission medium.

The CISCE, CIBCI, CIBCA, CI780, and CI750 employ unique protocols to provide services similar to those of DDCMP.

VAX Packetnet System Interface (VAX P.S.I.) is the software product that provides an interface to X.25 Packet Switching Data Networks (PSDNs). When DECnet-VAX is used in conjunction with VAX P.S.I., DECnet-VAX can use a virtual circuit (SVC or PVC) of the PSDN as though it were a standard datalink to transmit messages between DECnet nodes.

Note: Up to 128 X.25 virtual circuits are currently supported for Data Link Mapping (DLM), depending on CPU loading and capability. Refer to the VAX P.S.I. Software Product Description (SPD 25.40.xx) for more detailed information.

A VMS system can be used as either a control or a tributary node in a multipoint environment. DECnet-VAX supports a maximum of 32 tributaries controlled by one or more DMP11 or DMV11 control stations on a single node; a maximum of 8 tributaries can be controlled on one DMV11 multipoint line; a maximum of 16 tributaries can be controlled on one DMP11 multipoint line. The DMF32 can also be used with any UNIBUS VAX system as a tributary node. The DMP11 can be used in point-to-point communications configurations in DMC11 compatibility mode. The DMR11 is program-compatible with the DMC11 and is supported in DMC11 compatibility mode as well DMR11 mode.

The maximum throughput for a specific tributary node is equal to the maximum aggregate data rate for the control node divided by the sum of the number of active tributaries plus one.

When configuring a system with specific devices, please refer to the DECnet-VAX Load Unit Tables (included in this SPD) for calculating configuration loads and for support information.

DECnet-VAX Operation

DECnet-VAX is implemented under VMS as an Ancillary Control Process (ACP) and a network device driver with Digital-supplied executive-level components and user-level programs.

The normal VMS protection has been incorporated in the operation of DECnet-VAX. For example, incoming connects including file access and file transfer requests are protected by the normal VMS login and file protection mechanisms. Outgoing connects including file access and file transfer requests can include user password information that is implicitly specified via NCP, or explicitly specified by the user for verification on the remote node.

DECnet-VAX Configuration and Performance

The process of configuring a DECnet-VAX node is based primarily on trade-offs of cost, performance, and

functionality while satisfying the user's application requirements. It can be expected that network applications will range from low-speed, low-cost situations to those of relatively high performance and functionality. The performance of a given DECnet-VAX node is a function not only of the expected network traffic and resultant processing, but also of the amount of concurrent processing specific to that node. Thus, node performance depends on many factors including:

- CPU type
- Number and type of devices attached to the particular CPU
- Number of device interrupts per unit time
- Communication line(s) characteristics
- Number and size of buffers
- Message size and frequency of transmission
- Applications in use
- Size and frequency of route-through traffic (routing nodes only)

It is important to note that the rate at which user data can be transmitted (throughput) over a communications line can sometimes approach, but will never exceed, the actual line speed. The reason is that the actual throughput is a function of many factors, including the line quality, protocol overhead, topology, and network application(s), as well as the factors cited in this section.

Refer to the DECnet-VAX Load Unit Tables for maximum system configuration information.

HARDWARE REQUIREMENTS

Note:

1. If a device is not listed, that device is not supported by DECnet-VAX.
2. An asterisk (*) by a device description indicates that the particular device is no longer offered as an option.

Refer to the VMS Operating System Software Product Description (SPD 25.01.xx) for hardware requirements and processor support. Reference can be made to the configuration charts listed in the VMS Operating System SPD. For general device or controller descriptions, please refer to the *Networks and Communications Buyers Guide*.

One of the following communication devices is required:

DEUNA-AA	Ethernet controller interface.
DELUA	Ethernet controller interface, minimum revision level F1 required.
DEBNA	Ethernet 802.3-to-VAXBI Port Controller interface replacement for DEBNT. Concurrent use with DEBNT is not supported. The TK50/Ethernet port option is supported for concurrent TK50/Ethernet operation on packaged 8000-class workstation systems only.
DEBNI	Ethernet 802.3-to-VAXBI Port Controller interface. Similar to DEBNA in configuration, with increased performance, TK70 tape option disabled.
DEMNA	Ethernet/802.3-to-XMI high-performance Port Controller interface. Smaller footprint than DEBNI in configuration, with increased performance over the DEBNI.
DEMFA	XMI-to-FDDI high-performance Port Controller interface.
DMC11-AR, -DA*	Remote synchronous point-to-point interface, supports V.24/EIA RS-232-C, maximum speed 19.2 kilobits/second, full or half duplex. Not supported on DWBUA Adaptors.
DMC11-AL, -MD*	High speed local point-to-point synchronous interface, speed at 56 kilobits/second via coax, full or half duplex. Not supported on DWBUA Adaptors.
DMC11-AL, -MA*	High speed local point-to-point synchronous interface, speed at 1,000 kilobits/second via coax, full or half duplex. Not supported on DWBUA Adaptors.
DMC11-AR, -FA*	Remote CCITT V.35 point-to-point synchronous interface, speed up to 56 kilobits/second via modems (up to 250 kilobits/second via coax), full or half duplex. Not supported on DWBUA Adaptors.
DMR11-AA	Remote point-to-point synchronous interface, supports RS-423-A up 56 to kilobits/second or RS-232-C up to 19.2 kilobits/second, half or full duplex.
DMR11-AC	High speed local synchronous interface with integral modem for local connection, point-to-point, half or full duplex.
DMR11-AB	Remote CCITT V.35 synchronous interface, speed up to 56 kilobits/second via modems (up to 1,000 kilobits/second via local coax), point-to-point, half or full duplex.

DMR11-AE	EIA RS-422 synchronous interface, speed up to 1,000 kilobits/second (modem switch selectable speeds: 56, 250, 500, 1,000 kilobits/second), point-to-point, half or full duplex.	DMB32	VAX BI controller interface: T1012 /H3033 half or full duplex synchronous point-to-point only ports are compliant with RS232-C, RS422A/RS449, V.11, X.27, and V.35 and are compatible with RS423A/RS440, V.28/V.24, V.10, and X.26. T1012/H3033 asynchronous point-to-point only ports are compliant with EIA RS232-C and compatible with V.28/V.24. T1012 also compliant with RS423-A, V.10, and X.26, but H3033 distribution panel is not because of pin limitation on the 25 pin D-type connector.
DMP11-AA*	EIA RS-232-C up to 19.2 kilobits/second or RS-423-A (up to 56 kilobits/second) synchronous communication interface; can be used as multipoint control or tributary station; half or full duplex; configuration limitations based on number of tributaries.	DHB32	Asynchronous 16 line terminal multiplexer support for EIA RS-232-C or RS-423-A for BI-based system terminal connections. A maximum line speed of up to 19.2 kilobits/second with limited or no modem control for speeds above 9.6 kilobits/second and for the RS-423-A interface is supported.
DMP11-AB*	CCITT V.35 synchronous communication interface. Maximum data rate 56 kilobits/second; can be used as multipoint control or tributary station; half or full duplex; configuration limitations based on number of tributaries.	DHU11	Asynchronous 16 line RS-232-C controller interface, speed up to 9.6 kilobits/second, full modem control.
DMP11-AC*	Local synchronous communication interface with integral modem (switch selectable speeds: 56, 250, 500, or 1,000 kilobits/second. Maximum data rate 500 kilobits/second FDX or 1,000 kilobits/second HDX; can be used as multipoint control or tributary station; configuration limitations based on number of tributaries.)	DZ11	Asynchronous 16 line support for EIA RS-232-C or RS-423-A interface up to 9.6 kilobits/second, partial modem control.
DMP11-AE*	RS-422-A remote synchronous communication interface. The maximum data rate is 1,000 kilobits/second; can be used as multipoint control or tributary station; half or full duplex; configuration limitations based on number of tributaries.	DZ32	Asynchronous 8 line support for EIA RS-232-C or RS-423-A interface up to 9.6 kilobits/second, partial modem control.
DMF32-LP	Synchronous point-to-point or multipoint (tributary only) line support for RS-232-C or RS-423-A interface up to 19.2 kilobits/second, half or full duplex. Asynchronous point-to-point only line support for RS-232-C or RS-423-A interface up to 9.6 kilobits/second, half or full duplex. Supported on DWBUA Adaptors.	DMZ32	Asynchronous 24 line support for EIA RS-232-C or RS-423-A interface up to 9.6 kilobits/second. Modem support dependent on configuration.
DSB32	Synchronous, 2-line, half or full duplex point-to-point VAXBI communication interface supporting DDCMP (1 or 2 lines up to 64 kilobits/second) with full modem control.	CI750-AA, -AB	Interconnect for VAX-11/750 systems within a maximum distance of 90 meters. The effective maximum data rate of the CI750 using DECnet-VAX is limited to 1,000 kilobits/second between any pair of nodes.
		CI780-AA, -AB	Interconnect for VAX-11/750, VAX-11/780, VAX-11/782, VAX-11/785, VAX 8600, and VAX 8650 systems within a maximum distance of 90 meters. The effective maximum data rate of the CI780 using DECnet-VAX is limited to 1,000 kilobits/second between any pair of nodes.
		CIBCA	CI to BI interface Adaptor. The CIBCA-A ships on 82x0, 83x0, 85x0, 8700, 88x0, and 62x0 and is usable on those systems plus the 63x0 series. The CIBCA-B ships on the 8700, 88x0, 62x0, and 63x0, and is usable on those systems plus 82x0, 83x0.

CIBCI	CI to BI interface Adaptor. The CIBCI ships on 82x0, 83x0, 85x0, 87x0, and 8800, and is usable on all the above plus the 8810 and 8820N.	DSF32	DEC WANcontroller 620 — Two line synchronous communications controller designed specifically for the VAXft 3000 processors supporting DDCMP. DDCMP is supported at speeds up to 64 kilobits /second per line for a two-line operation.	
CISCE	CI Star Coupler Expander; allows for 16 more systems to be attached to the CI bus.	DMV11-AA	Point-to-point or multipoint (control or tributary station) synchronous line support for EIA RS-232-C up to 19.2 kilobits/second or RS-423-A (up to 56 kilobits/second) synchronous communication interface; half or full duplex; multipoint configuration limitations based on number of tributaries.	
MicroVAX and VAXstation system configurations require one of the following communication devices:			Point-to-point or Multipoint (control or tributary station) synchronous line support for RS-423-A/449 interface up to 56 kilobits /second; half or full duplex; multipoint configuration limitations based on number of tributaries.	
Note: For VAXstation 2000 systems, only one on-board asynchronous data/modem RS-232C serial line is supported up to 9,600 baud.				
For MicroVAX 2000 systems, up to 4 asynchronous data /modem RS-232C serial lines are supported up to 9,600 baud. The asynchronous ports on the MicroVAX 3100 and VAXstation 3100 are supported up to 9.6 kilobits /second with full modem control.				
DEQNA*	Ethernet Controller Interface — Minimum revision level required is K3.	DMV11-AC	Point-to-point or Multipoint (control or tributary station) synchronous line support used with integral modem for local connection up to 56 kilobits/second; half or full duplex; multipoint configuration limitations based on number of tributaries.	
DELQA	ETHERNET Controller Interface — Replacement for DEQNA. Minimum revision level required is C3. DELQA high performance ROM option (DEQTA) is also supported.	DMV11-AB	Remote point-to-point or multipoint (control or tributary station) CCITT V.35 synchronous line support up to 56 kilobits/second; half or full duplex; multipoint configuration limitations based on number of tributaries.	
DESVA	Ethernet controller interface for VAXstation 2000 and MicroVAX 2000 Systems.	DSH32	DEC TERMINAL/WAN CONTROLLER 581 — Combines DST32 and DHT32 functionality. Asynchronous 8 line EIA RS-232-C or RS-422/3-A interface up to 9.6 kilobits /second, no modem control; 1 line synch non-DMA DDCMP support up to 9.6 kilobits per second, DEC and Bell 200 modem compatible for bit- and byte-oriented protocols. Expansion Adaptor required for MicroVAX 2000 systems. Concurrent use with DHT32 or DST32 is not supported.	
DESQA	Ethernet Controller Interface for MicroVAX 3300/3400/3500/3600/3800/3900 series, VAXserver 3300/3400/3500/3600 series, and VAXstation 3300/3400/3500 series systems. High performance option (similar to DELQA ROM option) is supported.	DHV11	Asynchronous 8 line support for EIA RS-232-C or RS-423-A interface up to 9.6 kilobits /second, full modem control.	
DEQRA	The DEC TRNcontroller 100, a 4/16 Mbps selectable Q-bus controller, enables MicroVAX and VAX (Q-bus) systems to connect to an 802.5/Token Ring LAN. A DEC Token Ring Network Device Driver for VMS currently ships with the device and supports DECnet-VAX Phase IV.	DHQ11	Asynchronous 8 line support for EIA RS-232-C or RS-423-A interface up to 19.2 kilobits /second, with limited or no modem control for speeds above 9.6 kilobits/second and for the RS-423-A interface.	
DSV11	Synchronous, 2-line, half or full duplex point-to-point communication interface supporting DDCMP (1 or 2 lines up to 64 kilobits /second, or 1 line up to 256 kilobits/second).	DHT32	Asynchronous 8 line support for EIA RS-423-A interface up to 9.6 kilobits/second, no modem control. Concurrent use with DST32 is not supported.	
DIV32	Synchronous, full duplex point-to-point ISDN Basic Rate Access (2B+D) communication interface supporting DDCMP (1 or 2 'lines,' i.e., ISDN B-Channels at 64 kilobits/second multiplexed over the ISDN BRA interface). The 16 kilobits/second ISDN D-Channel also supported by the DIV32 is reserved for Digital use.			

DST32	Synchronous single line support for DDCMP up to 9.6 kilobits/second, full duplex for MicroVAX 2000 systems. Concurrent use with DHT32 is not supported. The DST32 is not supported on the VAXstation 2000.
CXY08	Asynchronous 8 line support for EIA RS-232-C interface up to 19.2 kilobits/second, full modem control, for VAX 3000 series systems.
DZQ11	Asynchronous 4 line support for EIA RS-232-C or RS-423-A interface up to 9.6 kilobits/second, partial modem control.
DZV11	Asynchronous 4 line support for EIA RS-232-C or RS-423-A interface up to 9.6 kilobits/second, partial modem control.

Note: The following RS-422/423 signals are not supported by the DECnet-VAX or VMS software:

NS — New Signal
 SR — Signaling Rate Selector
 LL — Local Loopback
 RL — Remote Loopback
 SS — Select Standby

CLUSTER ENVIRONMENT

DECnet-VAX is fully supported when installed on any valid and licensed VAXcluster* configuration without restrictions. The *HARDWARE REQUIREMENTS* sections of the DECnet-VAX Software Product Description (SPD 25.03.xx) and the VMS Operating System Software Product Description (SPD 25.01.xx), detail any special hardware required or not supported by this product.

VAXcluster software provides a distributed computing environment across a highly integrated set of VAX and /or MicroVAX systems that operate as a single environment. VAXcluster members can share many resources such as, disk and tape storage, CPU resources, and system management operations. Within this highly integrated environment, systems retain their independence because they use local, memory-resident copies of VMS. Thus, members can boot and fail independently while benefiting from common resources.

- * VAXcluster configurations are fully described in the VAXcluster Software Product Description (29.78.xx) and include CI, Ethernet, and Mixed Interconnect configurations.

GROWTH CONSIDERATIONS

The minimum hardware/software requirements for any future version of this product may be different from the requirements for the current version.

OPTIONAL HARDWARE

Communication devices may be added from the device class list up to, but not to exceed, the maximum defined by the DECnet-VAX SPD Load Unit Tables or the limits imposed by a bounded CPU system as mentioned in the VMS Operating System SPD (25.01.xx).

SOFTWARE REQUIREMENTS

- VMS Operating System V5.5
 Only the Base VMS Kit component is required.

OPTIONAL SOFTWARE

- VAX Packetnet System Interface (P.S.I.) V4.2
- VAX Packetnet System Interface Access V4.2
- VAX Wide Area Network Device Drivers V1.1 Kit is required for any synchronous device operation.
- DEC Token Ring Network Device Driver for VMS V1.0 kit is required for use of the DEC TRNcontroller 100.

The TCP/IP Services for VMS Software can be installed to provide a TCP/IP environment on a VMS system. TCP/IP Services for VMS includes capabilities such as file transfer (FTP), TELNET (X.25), Virtual Terminal support, and more. By purchasing and installing TCP/IP Services for VMS, the TCP transport can be used without a PAK under a DECwindows environment. To use the FTP and TELNET applications, the TCP/IP Services for VMS PAK must be installed in the License Management Facility (LMF). Refer to the TCP/IP Services for VMS Software Product Description (SPD 25.A4.xx) for more information.

VMS Tailoring

For VMS V5.x systems, the following VMS class is required for full functionality of this system integrated product:

- VMS Required Saveset

For more information on VMS classes and tailoring, refer to the VMS Operating System Software Product Description (SPD 25.01.xx).

INSTALLATION

Only experienced customers should attempt installation of this product. Digital recommends that all other customers purchase Digital's Installation Services. These services provide for installation of the software product by an experienced Digital Software Specialist.

Customer Responsibilities

Before Digital can install the software, the customer must:

- Ensure that system meets the minimum hardware and software requirements (as specified in the relevant SPDs).
- Prior to installing Digital hardware or software, obtain, install, and demonstrate as operational any modems and other necessary customer equipment or facilities to which Digital's communication hardware or software will connect.
- Designate one adjacent node to verify installation /connectivity.
- Make available for a reasonable period of time, as mutually agreed upon by Digital and the customer, all hardware communication facilities and terminals that are to be used during installation.

Delays caused by any failure to meet these responsibilities will be charged at the then prevailing rate for time and materials.

Installation for DECnet-VAX will consist of the following:

- Verification that all components of DECnet-VAX have been received.
- Verification that the necessary versions of the VMS software and documentation are available.
- Verification of the appropriate SYSGEN parameters.

Note: Should a software specialist be required to modify the previously installed operating system parameters, a time and materials charge will apply.

- Create any necessary DECnet-VAX accounts and directories.
- Enable software via License Product Authorization Key (PAK) registration.
- Define and create a local node DECnet database.
- Modify the system's startup command procedure to include startup of the DECnet-VAX network.
- Verify the proper installation of DECnet-VAX by running a series of tests to show connectivity to a designated node.

Connectivity to all other nodes within the network is the responsibility of the customer. Digital recommends the use of the NCP facility to help verify connectivity.

ORDERING INFORMATION

DECnet-VAX software is shipped on the VMS Kit for all processors including MicroVAX-based processors.

This software product supports the VMS License Management Facility and will be enabled by a License Product Authorization Key (PAK), which is included as part of the purchase of a Single-Use License. License units for this product are allocated on a per-CPU basis and not dependent on CPU Capacity or User/Activity.

For more information on the License Management Facility, refer to the VMS Operating System Software Product Description (SPD 25.01.xx) or the *License Management Facility* manual of the VMS Operating System documentation set.

DECnet-VAX licenses also include the right to use DECnet-VAX Extensions. DECnet-VAX Extensions kit gives the user the opportunity to use the OSI products available for use with DECnet-VAX. DECnet-VAX Extensions kit has separate documentation and media kits. Refer to the Software Product Description (SPD 29.03.xx) for further information.

A separate license PAK is needed for each CPU on which the software product will be used (except as otherwise specified by Digital). Materials and Service Options are then selected to use the product more effectively. THE LICENSE OPTIONS ARE DESCRIBED BELOW. IF YOU ARE NOT FAMILIAR WITH THE SERVICE OPTIONS, YOU MAY OBTAIN THE APPROPRIATE SOFTWARE PRODUCT SERVICE DESCRIPTION(S) FROM YOUR LOCAL DIGITAL OFFICE.

Base License Option Numbers for DECnet-VAX are:

End Node	QL-D04A*-AA
Full Function	QL-D05A*-AA
Migration Option	QL-D09A*-AA

* Denotes processor variant. Migration indicates an upgrade from End Node (EN) to Full Function (FF). Contact your local Digital Sales Office for Rental License Option availability.

LICENSE OPTIONS

Single-Use License Option

The Single-Use License provides the right to use the software product on a single CPU. Single-Use licensed software is furnished under the licensing provisions of Digital Equipment Corporation's Standard Terms and Conditions.

For the first installation of this software product the user must purchase, as a minimum:

- Single-Use License Option, and

- One VMS Extended Documentation Option
(Includes full DECnet-VAX Documentation)

The license gives users the right to use the software on a single CPU and includes the delivery of a License Product Authorization Key (PAK) to enable the DECnet-VAX software. The VMS Distribution and Extended Documentation Options provide the machine-readable software and related documentation.

To use this software product on additional CPUs, users must purchase a Single-Use License Option for each CPU.

The one-time right to copy the software is no longer included with the Single-Use License Option. For additional CPUs, since DECnet-VAX software is included on the VMS Distribution media, users only need the one-time right-to-copy license for VMS. The VMS Extended or the VMS Base Documentation Options are not required, but the VMS Base Documentation is recommended for additional CPUs. Note that the VMS Base Documentation does not include the full set of DECnet-VAX documentation but is sufficient for those users who need to get started using the basic capabilities of DECnet-VAX.

Migration Option — DECnet-VAX End Node to Full Function

Current licensed users of DECnet-VAX End Node software are eligible for the Migration Option to upgrade a system from End Node capability to Full Function capability. This is a Single-Use License offered at a reduced price and provides all of the License rights described above under a full function license.

For each CPU running DECnet-VAX End Node that is to be upgraded to Full Function, the user must purchase, as a minimum:

- Migration Option Single-Use License

Documentation Option

Users will receive DECnet-VAX documentation as part of either the VMS Extended or VMS Base Documentation Options. Note that the VMS Extended Set contains the full DECnet-VAX Networking Documentation while the Base set contains a subset of this information for users who need only to get started using DECnet-VAX. Users do not need to order any license option to obtain documentation; users need only order those manuals or sets that are appropriate for their needs.

It is suggested that the VMS Extended Documentation Option be purchased as system management becomes

more important; however, only the VMS Base Documentation Option is needed to use the DECnet-VAX software to get started. When revised versions of this software product become available, users may obtain additional copies of the documentation by purchasing either VMS option again or by purchasing individual manuals. For the user's convenience, a separate DECnet-VAX Documentation-only Kit is available (QA-001AN-GZ).

SOFTWARE LICENSING

This software is furnished under the licensing provisions of Digital Equipment Corporation's Standard Terms and Conditions. For more information about Digital's licensing terms and policies, contact your local Digital office.

License Management Facility Support:

This System Integrated Product (SIP) supports the VMS License Management Facility.

License units for this product are allocated on a per-CPU basis and are not dependent on CPU Capacity or User/Activity.

For more information on the License Management Facility, refer to the VMS Operating System Software Product Description (SPD 25.01.xx) or the *License Management Facility* manual of the VMS Operating System documentation set.

For more information about Digital's licensing terms and policies, contact your local Digital office.

SOFTWARE PRODUCT SERVICES

A variety of service options are available. For more information, contact your local Digital office.

Note: If a device is not listed, that device is not supported by DECnet-VAX.

Hardware Configurations:

The following tables describe the physical hardware configurations supported by DECnet-VAX in terms of CPU type and communication interface. The numbers given in the tables are load units.

Load units are incurred when a device is in active operation at the indicated speed. An idle device incurs no load. However, in general, systems should be configured so they can sustain peak load rates.

Configuration limits such as power supply, air conditioning, and backplane space requirements are not considered in the following tables. Please verify system configurations with your Digital representative. In addition, please note that each device requires its own memory

space for buffering and link control. Particular consideration should be taken when configuring eight or more DECnet-VAX links on a single CPU; if in doubt, please contact your Digital representative.

Instructions for using the following tables:

Each communications device belongs to one of the following three classes:

Class I	—	DMA devices with firmware datalink protocol
Class II	—	DMA devices with datalink protocol in handling software
Class III	—	Low end non-DMA devices with software-handling datalink protocol and primarily per-character interrupts

Listed below are the communications devices and the class in which each belongs.

Each device class and line speed combination is associated with the following load units:

Load Units by Line Speed and Device Class

	Line Speed (kilobits/second)			
	9.6	19.2	56	>56
Class I	8	16	45	100
Class II	10	20	52	115
Class III	13	26	n/a	n/a

Note: For speeds under 9.6 kilobits/second (9,600 baud), load units are proportional. Thus a 2,400 baud Class III (e.g., a DZV11) line would represent about 3 units.

Each CPU can support a given number of load units. In general, the faster the CPU the greater the number of load units it can support. The load units that can be supported by each CPU are:

Load Units by CPU Type

CPU	Load Units	Main BUS Type
VAX 9xxx-xxx	5400	XMI/BI
VAX 8810,20,30,40	1500	XMI/BI
VAX 8800/VAX 8700	1350	BI
VAX 6000-4xx	1300	XMI/BI
VAX 8650	1200	BI/UNIBUS
VAX 8550	1200	BI
VAX 6000-3xx	945 (formerly 63xx)	XMI/BI

VAX 8530	940	BI
MicroVAX 3800/3900	865	Q-bus
VAX 8600	790	BI
VAX 8500	790	BI
VAX 6000-2xx	655 (formerly 62xx)	XMI/BI
VAX 4xxx	640	Native/Q-bus
MicroVAX 3xxx, VAXstation 3xxx	640	Q-bus
VAX FT3xxx	560	Q-bus
VAX-11/785	360	UNIBUS
MicroVAX II, VAXstation II	280	Q-bus
VAX-11/782	240 ²	UNIBUS
VAX-11/780	240	UNIBUS
VAXstation 8000	240	Q-bus
VAX 8250, VAX 8350	240	BI
VAX 8200, VAX 8300	200	BI
VAX-11/750	170	UNIBUS
MicroVAX 2000/ VAXstation 2000	170 ¹	Q-bus/Native
MicroVAX I, VAXstation I	100 ²	Q-bus
VAX-11/725, VAX-11/730	100 ²	UNIBUS

¹ For VAXstation 2000 systems, only one asynchronous data/modem RS-232C serial line is supported up to 9,600 baud. For MicroVAX 2000 systems, up to 4 asynchronous data/modem RS-232C serial lines are supported up to 9,600 baud.

² The following CPUs are no longer offered:

VAX: VAX-11/725, VAX-11/730, VAX-11/782
 MicroVAX: MicroVAX I, MicroVAX 3300 packaged systems and all MicroVAX 3400, MicroVAX 3800, MicroVAX 3900 systems
 VAXstation: VAXstation I and packaged VAXstation 3300 systems

The maximum system configuration, with a mix of device types, is computed by adding the load costs (in load units) for each device up to the limit for a given processor type. For general information on possible supported configurations, see the configuration charts in the VMS Operating System Software Product Description (SPD 25.01.xx).

Example:

For a VAX-11/750 used to route messages in a DECnet network:

Assume that the system uses a DMR11 (Class I device) at 500 kilobits/second, a DMR11 (Class I device) at 19.2 kilobits/second and the synchronous line of a DMF32 (Class I device) at 19.2 kilobits/second. When the network is heavily used, the processor loading totals 136 load units. Adding a device with a load of greater than 34 load units (e.g., another DMR11 at 56 kilobits/second) would mean that the VAX-11/750 may not be able to sustain heavy demand.

Device Classes

Device Type	Class
DELUA ¹	I
DEUNA ¹	I
DEBNA ¹	I
DEBNI ¹	I
DEMNA ¹	I
DEMFA ¹	I
DHU11 ²	II
DMC11	I
DMR11	I
DMP11	I
Device Type	Class
DMF32 (synch)	II
DMF32 ² (asynch)	II
DSB32	II
DMB32 (synch)	II
DMB32 ² (asynch)	II
DSV11	II
DIV32	II
DSF32	II
DMV11 ³	I
DSH32 (synch)	II
DSH32 ² (asynch)	II
DZ11 ²	III
DZ32 ²	III
DMZ32 ²	III
CXY08	II
CI780 ⁴	I
CI750 ⁴	I
CIBCA	I
DEQNA ¹	I
DELQA ¹	I
DESQA ¹	I

DESVA ¹	I
DEQRA ¹	I
DHV11 ²	II
DHQ11 ²	II
DHT32 ²	II
DST32 ²	II
DHB32	II
DZV11 ²	III
DZQ11 ²	III

¹ When two or more Ethernet, FDDI, or 802.5/Token Ring controllers are used on a single CPU, each controller must be connected to a different Ethernet, FDDI, or 802.5/Token Ring cable. These cables must not be joined by a bridge or a repeater, though they may be joined by another DECnet router.

² Load costs are for each line of a device at 9,600 baud. Higher data rates are not supported.

³ Load costs are for each line at 56 kilobits/second. Higher data rates are not supported.

⁴ DECnet-VAX supports up to 16 VAX systems connected to one SC008 star coupler via CI780/750 interfaces. The effective maximum data rate through the CI780/750 using DECnet-VAX is limited to 1,000 kilobits/second at each node.

Support for Multiple Ethernet Adaptors on Different Bus Types

VMS support for multiple Digital-supplied Ethernet Adaptors on different bus types allows for:

1. The added capability of Digital's existing multi-rail support
and
2. The additional throughput capability of newer, faster devices while maintaining customer investment in supported older devices

The following combinations are possible:

Bus Type	Adaptor	CPUs Affected
XMI and FDDI	DEMFA	VAX 6000-500
XMI and BI	DEMNA, DEBNA, DEBNI	VAX 6xxx, VAX 88xx VAX 9xxx, VAX 8700

Bus Type	Adaptor	CPUs Affected
Q-bus and Integrated Ethernet Controller	DELQA/DEQTA (DELQA-Plus or DESQA) DESVA	MicroVAX 3xxx
Q-bus and Integrated Ethernet Controller	DELQA/DEQTA (DELQA-Plus or DESQA) SGEC	VAX 34xx, VAX 4xxx

The following table indicates supported configurations:

CPU Type	DECnet-VAX Load Units	Combination Bus Support
VAX 9xxx-xxx	5400	Any combination of XMI or BI Adaptors up to a maximum of 6 adaptors
VAX 6000-5xx	1200	Any combination of XMI to FDDI Adaptors up to a maximum of 6 adaptors
VAX 6000-4xx VAX 6000-3xx VAX 6000-2xx	1200 945 655	Any combination of XMI or BI Adaptors up to a maximum of 6 adaptors
MicroVAX and VAXstation 3xxx	640	2 Q-bus adaptors maximum 1 Native adaptor maximum or a combination up to 2 adaptors of Native and Q-bus
VAX 4xxx and VAX 34xx	640	2 Q-bus adaptors maximum 1 Native adaptor maximum or a combination up to 2 adaptors of Native and Q-bus

Restrictions

Note: If the configuration is not listed here, that configuration is not currently supported by DECnet-VAX.

1. UNIBUS support does not change. DELUA and DEUNAs are still supported at current levels. No combinations beyond existing support are supported.
2. The Q-bus environment is limited to two adaptors on the same bus type.
3. Failover of adaptors is limited to DECnet protocol traffic ONLY. SCA VAXcluster traffic is not supported on multiple adaptors on the same CPU for example.
4. No more than TWO different bus types with Ethernet Adaptors are supported per any CPU.
5. Multiples of different adaptors are supported ONLY for Digital Ethernet Adaptor hardware.

6. Should average Ethernet utilization exceed 15 percent on average then failover is not guaranteed from a higher performance device to a lower performance device.

To achieve a viable configuration, the user and/or a Digital software specialist must perform a level of application analysis that addresses the factors stated.

SOFTWARE WARRANTY

Warranty for this software is provided by Digital with the purchase of a license for the product as defined in the Software Warranty Addendum of this SPD.

- ® MS-DOS is a registered trademark of Microsoft Corporation.
- ™ The DIGITAL Logo, CI, DECnet, DELUA, DECnet-DOS, DECnet-VAX, DECwindows, MicroVAX, Packetnet, PATHWORKS, PDP-11, Q-bus, Rainbow, RSX-11, TK, ULTRIX, UNIBUS, VAX, VAX MACRO, VAXBI, VAXft, VAXcluster, VAXmate, VAXstation, VAXserver, VMS, and XMI are trademarks of Digital Equipment Corporation.

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Cover Letter for DECnet-VAX Version 5.5

AV-DL04K-TE

DECnet-VAX Version 5.5 is fully integrated with VMS Version 5.5.¹ Therefore, all orders that include the VMS Version 5.5 media and documentation kit also include DECnet-VAX images and documentation.

With the purchase of a DECnet-VAX Version 5.5 license, you will receive a Product Authorization Key (PAK), which enables network functionality on a system. A DECnet-VAX license grants the right to use the product as specified in the DECnet-VAX Software Product Description (SPD 25.03.xx.)

Using the License Management Facility, you can register either a DECnet-VAX end-node PAK (DVNETEND) or a full-function PAK (DVNETRTG). For more information on the License Management Facility, refer to the *VMS License Management Utility Manual*.

DECnet-VAX Extensions

The DECnet-VAX Extensions software, separately orderable, provides additional services for the DECnet-VAX environment. Use of these services is licensed under the DECnet-VAX license. (See SPD 29.03.xx). The DECnet-VAX Extensions offers the following:

- Use of the VAX Distributed Name Service for node names and addresses
- OSI stack with support for:
 - File Transfer, Access, and Management (FTAM)
 - Association Control Service Element (ACSE)
 - Presentation
 - Session
 - Transport
 - Connection Oriented Network Service (CONS) and Connectionless Network Service (CLNS) networks over Ethernet and X.25
- Network management using the Network Control Language
- Tools for easy node name management and for network management support

Ordering Information for DECnet-VAX Extensions

Use the following information to order DECnet-VAX Extensions:

Software Licenses: None

Software Media: QA-D04AB-xx² (includes software documentation)

Software Documentation: QA-D04AB-GZ

QA-D04AC-GZ (Programming Supplement)

QA-D04AD-GZ (X.25/P.S.I. Supplement)

¹ The following are trademarks of Digital Equipment Corporation: CI, DECnet, DEQNA, Digital, Q-bus, ULTRIX, VAX, VAXcluster, VMS, and the DIGITAL logo.

² Denotes variant fields. For additional information on available licenses, services, and media, see your Digital sales representative.

Software Product Services: None

The DECnet-VAX Extensions software is licensed by, and serviced under, DECnet-VAX Software Licenses (QL-D04A*.* or QL-D05A*.**) and Software Product Services (QT-D04A*.* or QT-D05A*.*).

VMS Support for TCP/IP Environment

The VMS ULTRIX Connection (UCX) software, separately orderable, can be installed to provide a TCP/IP environment on a VMS system. UCX includes capabilities such as the file transfer protocol (FTP) and virtual terminal support. By purchasing and installing UCX software, the TCP transport can be used without a PAK in the VMS DECwindows environment. To use the FTP application, the UCX PAK must be installed in the VMS License Management Facility (LMF). Refer to the UCX Software Product Description (SPD 23.A4.xx) for more information.

Planned Withdrawal of Device Support

As of VMS Version 5.4-3, local area VAXcluster software does not support the DEQNA Q-bus to Ethernet adapter. If a node in your cluster is connected through the DEQNA device, you must replace the DEQNA with a DELQA or a DESQA before updating to VMS Version 5.4-3 or upgrading to VMS Version 5.5. Contact your Digital sales representative for information about the DEQNA upgrade program. Refer to the VMS Version 5.5 cover letter for additional information.

Also, within the next 12 to 15 months, VMS and DECnet-VAX will withdraw functional support for the DMV11 synchronous communications device. Customers can continue to use a customer-developed driver to access the DMV11 and DMR11. However, DECnet-VAX and VMS will no longer use this device for any native communication operations. Service contracts for the hardware will be honored for 12 to 24 months after retirement of the software driver. Notification of retirement will be listed in the DECnet-VAX cover letter in a future release. See the VAX Wide-Area Device Drivers Software Product Description (SPD 29.64.xx) and cover letter for more information.

Digital recommends that customer implementations using the DMV11 obtain the DSV11 synchronous communications device upgrade as soon as possible. Customer upgrade options currently are available from DECdirect. Contact your local Digital sales representative for more information.

Planned Additional Device Support

DECnet-VAX Version 5.5 does not support the CIXCD adapter. Support for this adapter is planned for a future release of DECnet-VAX. Also, as of DECnet-VAX Version 5.5, CNDRIVER support for all other CI adapters is limited to a single adapter per VAX system. Multiport device support is planned for a future release of DECnet-VAX.

Documentation

For systems that you will use to manage your network, Digital recommends that you purchase the System Management Subkit of the VMS Extended Documentation Set, which includes all manuals for DECnet-VAX and VAXcluster software. Individual DECnet-VAX manuals or the two DECnet-VAX volumes can be ordered separately. For more details about DECnet-VAX documentation, see the *Overview of VMS Documentation*.

Cover Letter for VMS™ Version 5.5

AV-EF56L-TE

Digital is pleased to provide VMS Version 5.5, which includes the following enhancements: an improved Batch/Print system, the integration of extended LAT functionality, DECthreads, a new Movefile function, and support for new VAX computer systems.¹

Because extended LAT functionality is now integrated into VMS Version 5.5, do not attempt to install the optional LAT software provided with previous versions of VMS, as the installation will overwrite the VMS Version 5.5 LAT software.

For more information about these enhancements, see the *VMS Version 5.5 New Features Manual*.

NOTE

The information in this cover letter supersedes the information in other Digital documentation supplied with VMS Version 5.5.

Upgrade and Installation

The *VMS Version 5.5 Upgrade and Installation Manual* contains step-by-step instructions for upgrading and installing VMS Version 5.5 and VMS DECwindows Version 5.5. This manual must be used with the upgrade and installation supplement for individual VAX computers.

The increased size of the VMS operating system and DECwindows software requires larger system disks. The full VMS operating system requires 100Mb of disk space; consequently, the RD53 fixed disk is no longer supported as a VMS system disk. The full VMS operating system with DECwindows software requires 115Mb of disk space; consequently, the RZ23 fixed disk is not supported as a VMS system disk with the VMS DECwindows environment. When a smaller disk is used, tailoring is required prior to installing some VMS options. Refer to the *VMS Version 5.5 Upgrade and Installation Manual* for information on tailoring.

The new Batch/Print queuing system relies on Interprocess Communication Services (IPC), an internal interface. To ensure that IPC and the new queuing system operate correctly on VMS Version 5.5, you must correctly define the SYSGEN parameters SCSNODE and SCSSYSTEMID on all VAX systems. Unlike earlier versions, VMS Version 5.5 requires that these parameters be defined on systems that are standalone, networked, or in a VAXcluster. See Section 6.5 in the *VMS Version 5.5 Upgrade and Installation Manual* for information on how to set the SYSGEN parameters SCSNODE and SCSSYSTEMID.

Please note that the VMS Version 5.5 upgrade procedure will restore your site-specific files (for example, SYSTARTUP_V5.COM) in SYS\$COMMON with two exceptions: SYSHUTDWN.COM and SYSECURITY.COM are not restored. After the upgrade, your site-specific versions of these two files will be previous versions of these files. Additionally, any site-specific startup files in SYS\$SPECIFIC are not restored during the upgrade. Before upgrading your system, please take appropriate steps to preserve your current versions of SYSHUTDWN.COM, SYSECURITY.COM, and any other site-specific files in SYS\$SPECIFIC.

¹ The following are trademarks of Digital Equipment Corporation: CI, DEQNA, DECbridge, DECnet, DECwindows, Digital, DSSI, HSC, LAT, MSCP, VAX, VAXcluster, VMS, and the DIGITAL logo.

CAUTION

VMS Version 5.5 provides only limited support for the DEQNA device. Read the DEQNA Support section in Appendix A of this letter before installing VMS Version 5.5 on a system that contains a DEQNA device.

Rolling Upgrade Restrictions

If your configuration contains at least two computer systems with CIXCDs that boot from different system disks, and you plan to keep at least one of those systems at VMS Version 5.4-3, you must install a patch to all the VMS Version 5.4-3 system disks before you begin the rolling upgrade to VMS Version 5.5. See Section 7.2 in the *VMS Version 5.5 Upgrade and Installation Manual* for more information on installing the patch. This patch does not apply if you are performing a rolling upgrade from a version of the VMS operating system prior to Version 5.4-3.

Before beginning a rolling upgrade to VMS Version 5.5, check the value for SCSMAXMSG on each node in the VAXcluster. The value should be at least 132. If a node has a SCSMAXMSG value of less than 132, increase it to at least 132 using SYSGEN and reboot that node. Failure to do so will either cause the nodes running VMS Version 5.5 to CLUEXIT, or the nodes with a SCSMAXMSG value of less than 132 to CLUEXIT.

Kit Contents: Media

Enclosed is the VMS Version 5.5 media. VMS Version 5.5 is distributed on the following media:

- Compact disc
- Nine-track, 1600 bpi magnetic tapes
- TK50 tape cartridges

Kit Contents: Documentation

The complete VMS Version 5.5 Extended Documentation Set contains over 100 manuals that describe every aspect of using the VMS operating system for daily operations, system management, and programming. The documentation set is organized into several kits to provide a wide range of choices for the level of information required. For more information, see the *Overview of VMS Documentation*.

The Release Notes Kit includes cover letters, Software Product Descriptions (SPDs), the *VMS Version 5.5 Release Notes*, the *Overview of VMS Documentation*, and the *VMS Version 5.5 New Features Manual*.

Complete documentation for VMS Version 5.5 will be available on the March 1992 VMS Online Documentation Library (OLD) compact disc for use with the VMS DECwindows Bookreader.

New Manuals for VMS Version 5.5

The following printed manuals are new for VMS Version 5.5:

Building Dependable Systems: The VMS Approach
Guide to DECthreads
VMS LAD Control Program (LADCP) Manual

New Using VMS BACKUP Manual

A new manual, *Using VMS BACKUP*, is available to help new users complete common backup tasks with the VMS Backup Utility (BACKUP). Intended as a temporary companion to the *VMS Backup Utility Manual*, *Using VMS BACKUP* includes information about disk and tape operations, backing up and restoring files, directories, and disks, troubleshooting, and creating your own BACKUP command procedures. Because we intend to merge the information in *Using VMS BACKUP* into the printed Backup Utility documentation in a future release, we are only providing online versions with VMS Version 5.5.

After you install or upgrade to VMS Version 5.5, *Using VMS BACKUP* is available on your VMS system disk (SYS\$EXAMPLES:USING_BACKUP.*) in .DECW\$BOOK, .TXT, and .PS format. You must either print the file or view it using Bookreader.

To view the book using Bookreader, you need to perform the following steps:

1. Add the following line to your DECW\$BOOK:LIBRARY.DECW\$BOOKSHELF file:

```
BOOK\SYS$EXAMPLES:USING_BACKUP\Using VMS Backup
```

NOTE

When editing the LIBRARY.DECW\$BOOKSHELF file:

- **Do not allow any lines to wrap.**
- **Do not add any blank lines.**

2. Restart the VMS DECwindows Bookreader. The book title will appear in the library window.

Documentation on the VMS Compact Disc

In addition to the VMS Version 5.5 software, the VMS Version 5.5 compact disc distribution kit includes the SPD and the following two manuals: the *VMS Version 5.5 Release Notes* and the *VMS Version 5.5 Upgrade and Installation Manual*. Both manuals are in ASCII text format, readable on your terminal, and also in .DECW\$BOOK format, readable with the VMS DECwindows Bookreader.

VMS DECwindows Software

VMS Version 5.5 is the final functional release to contain integrated VMS DECwindows software. Customers who want to continue to use VMS DECwindows software must obtain the VMS DECwindows Motif² layered product. Please contact your local Digital representative for information on how to acquire VMS DECwindows Motif Version 1.0 (SPD 36.09.xx).

Introducing VMS DECwindows Motif Version 1.0 Software

Effective August 23, 1991, VMS DECwindows software is now packaged as a separate layered product called VMS DECwindows Motif Version 1.0. Previously, VMS DECwindows software was delivered as part of the VMS operating system.

Providing VMS DECwindows as a layered product gives our customers an advantage over the previous method of packaging VMS DECwindows with the VMS kit. By decoupling VMS DECwindows Motif from VMS releases, new OSF/Motif releases can be supplied to our VMS DECwindows customers more frequently. VMS DECwindows Motif Version 1.0 provides both Digital's X User Interface (XUI) and Motif environments.

As a separately licensed and packaged layered product, VMS DECwindows Motif Version 1.0 complies with the License Management Facility (LMF) and requires a license Product Authorization Key (PAK). Your license PAK must be registered and loaded to install and run VMS DECwindows Motif Version 1.0 software.

VMS DECwindows Motif Workstation Packaging Program

A VMS DECwindows Motif capacity workstation license PAK will be included with every VAXstation running the VMS operating system at no additional cost.

² The following are registered trademarks of the Open Software Foundation, Inc.: Open Software Foundation, OSF, OSF/Motif, and Motif.

Prerequisite Operating System and Memory Hardware Requirements for VMS DECwindows Motif

VMS Versions 5.4-3 and 5.5 contain proactive memory management mechanisms that allow VMS DECwindows Motif Version 1.0 to support 8Mb systems. VMS Versions 5.4 through 5.4-2 running VMS DECwindows Motif software require 12Mb systems.

APPENDIX A

ADDITIONAL RELEASE NOTES FOR VMS VERSION 5.5

DEC FDDIcontroller 400 (DEMFA) Restrictions

DEC FDDIcontroller 400 (DEMFA) controllers with Version 1.2 firmware do not function correctly in promiscuous mode. Any product (for example, Ethernim) that attempts to put the DEMFA into promiscuous mode receives the following error:

```
%SYSTEM-F-DEVREQERR, device request error
```

DEMFA controllers with Version 1.3 or later firmware correctly support promiscuous mode.

DEQNA Support

As of VMS Version 5.4-3, VAXcluster software did not support the DEQNA™ Q-bus to Ethernet adapter. If a node in your VAXcluster is connected through a DEQNA device, you must replace the DEQNA with a DELQA or a DESQA before updating to VMS Version 5.4-3 or upgrading to VMS Version 5.5. Contact your Digital representative for information about the DEQNA upgrade program.

VMS Version 5.5 withdraws support for the DEQNA device, except for access using the QIO or ALTSTART interfaces. Within 18 months, a release of the VMS operating system will withdraw all support for the DEQNA; after you install that future release, the Ethernet driver will place the DEQNA device in an OFFLINE state, rendering it inoperative.

To determine if your system has a DEQNA device installed, use the System Dump Analyzer (SDA) command SHOW DEVICE. The SHOW DEVICE command produces several displays that describe the devices in the system configuration. If your system has a DEQNA installed, it will be listed at the top of the first screen. For example:

```
$ ANALYZE/SYSTEM
SDA> SHOW DEVICE XQAO

I/O data structures
-----
XQAO          DEQNA          UCB address: 807084D0

Device status: 00002010 online,template
Characteristics: 0C042000 net,avl,idv,odv
                  00000000

Owner UIC [000000,000000] Operation count      0   ORB address 80708730
      PID     00000000    Error count           0   DDB address 8091F680

Class/Type      20/21 Reference count        0   DDT address 80700074
Def. buf. size   512    BOFF                 0140  CRB address 808D9D30
DEVDEPEND      00000000 Byte count            003C  I/O wait queue empty
DEVDEPND2      00000000 SVAPTE               80FF09E0
FLCK index       34    DEVSTS              0000
DLCK address    8091F5A0
Charge PID      00000000

*** I/O request queue is empty ***
```

If your system has two Ethernet controllers, use the SDA command SHOW DEVICE XQAO to check the first Ethernet for a DEQNA device. Then use SHOW DEVICE XQB0 to check the second Ethernet.

Layered Product Support

The following layered products are incorrectly listed in the Layered Product Availability Table, Appendix E, in the *VMS Version 5.5 Upgrade and Installation Manual*:

- DECmcc DECnet IV Diagnosis Functional Module for VMS, Version 1.1 is not currently available.
- DECndu (Network Device Upgrade) Utility for VMS, Version 1.0. If previously installed, Version 1.0 will continue to work after an upgrade to VMS Version 5.5; however, it will not install on VMS Version 5.5. The next release of DECndu will install and support VMS Version 5.5.
- DEC Security Reporting Facility for VMS, Version 1.1A. If previously installed, Version 1.1A will continue to work after an upgrade to VMS Version 5.5; however, it will not install on VMS Version 5.5. The next release of DEC Security Reporting Facility will install and support VMS Version 5.5.

Standalone BACKUP

VMS Version 5.5 has two problems with standalone BACKUP: one occurs when the console terminal has an attached hardcopy printer; the other occurs when performing a backup operation with a SCSI tape device.

Console Terminal and Printer Problem

VMS Version 5.5 of standalone BACKUP causes hangs on some systems that have hardcopy printers attached to the console VT terminal. The hang occurs in the following three situations:

- When responding to small console media questions (for example, RX50 or TU58)
- When responding to device mount questions
- When responding to standalone BACKUP mount questions

The questions normally expect a "YES" reply; the hang occurs on the "Y" character.

Examples of each situation follow:

1. If the system console VT terminal has an attached hardcopy printer and you are booting from small console media, the following message and prompt appear:

```
Please remove the volume "SYSTEM_1" from the console device.  
Insert the next standalone system volume and enter "YES" when ready: Y
```

The system then hangs and the characters "ES" are not echoed.

2. If the system console VT terminal has an attached hardcopy printer, the standalone BACKUP command, message and prompt appear as follows:

```
$ backup/image/verify mka100:VMS055.B/save dka0:  
%BACKUP-I-READYREAD, mount volume 1 on _SABKUP$MKA100: for reading  
Enter "YES" when ready: Y
```

The system then hangs and the characters "ES" are not echoed.

3. If the system console VT terminal has an attached hardcopy printer, the Standalone Configuration message and prompt appear as follows:

```
Enter "YES" when all needed devices are available: Y
```

The system then hangs and the characters "ES" are not echoed.

A fix for this console VT and hardcopy printer problem is under investigation; however, a simple workaround is available. Remove the attached hardcopy printer or disable the printer port utilizing the VT terminal's setup parameters.

SCSI Tape Device Problem

When performing backup with an online mounted SCSI tape device, VMS Version 5.5 standalone BACKUP incorrectly generates "%BACKUP-I-READYWRITE" or "%BACKUP-I-READYREAD" messages and prompts the user to mount the tape and enter "YES" when restoring the VMS055.B save set.

Following is an example of the incorrect messages generated by standalone BACKUP:

```
$ backup/image/verify mka100:VMS055.B/save dka0:  
%BACKUP-I-READYREAD, mount volume 1 on _SABKUP$MKA100: for reading  
Enter "YES" when ready: yes  
%BACKUP-I-STARTVERIFY, starting verification pass  
%BACKUP-I-READYREAD, mount volume 1 on _SABKUP$MKA100: for reading  
Enter "YES" when ready: yes  
%BACKUP-I-PROCDONE, operation completed. Processing finished at ....
```

The problem exists in the MKDRIVER.EXE and is fixed on the VMS Version 5.5 mandatory update (MUP).

NOTE

Digital recommends that you rebuild standalone BACKUP after completing the Version 5.5 installation or upgrade and applying the MUP, so that you incorporate the fix into your version of standalone BACKUP. Refer to your VAX computer-specific upgrade and installation supplement for directions on building a standalone BACKUP kit.

SYSGEN SHOW/ADAPTER Command Errors

When running SYSGEN, the SHOW/ADAPTER command (shown in Example 1) displays the information "Unknown0" during adapter output (see ①). All nexus entries for modules displayed after the "Unknown0" are not correct (see ②). These nexus entries are too high by one. To get the correct nexus slot information, use the SYSGEN command SHOW/CONFIGURATION (shown in Example 2).

Example 1: SYSGEN Command SHOW/ADAPTER

```
$ MCR SYSGEN ! Start SYSGEN program.  
SYSGEN> SHOW /ADAPTER ! Issue SHOW/ADAPTER command.  
CPU Type: VAX 6000-620 ! CPU type is displayed.  
  
Nexus (decimal) Generic Name or Description  
0010 16 XMI - 6000-600 processor  
0020 32 XMI - 6000-600 processor  
0030 48 XMI - NI adapter (DEMNA)  
0060 96 XMI - Disk/Tape Adapter (KDM70)  
0080 128 XMI - memory module  
0090 144 XMI - memory module  
XMI - BI Adapter (DWMBB/A)  
0010 16 Unknown0 ① ! Error shown here.  
00A2 162② BI - Disk Adapter (KDB50) ③ ! Nexus of all adapters that  
00A3 163② BI - XMI Adapter (DWMBB/B) ! follow the error also  
00A6 166② BI Combo Board (DMB32) ! are not correct.  
00A7 167② BI - Synchronous Comm Option (DSB32)
```

Example 1 (continued on next page)

Example 1 (Cont.): SYSGEN Command SHOW/ADAPTER

00B2	1782	BI Combo Board (DMB32)
00B3	1792	BI - XMI Adapter (DWMBB/B)
00B4	1802	DRB32
00B6	1822	CIO
00D8	2162	BI - XMI Adapter (DWMBB/B)
00D9	2172	BI - NI Adapter (DEBNI)
00DA	2182	BI Combo Board (DMB32)
00DD	2212	BI - TK70 Adapter (TBK70) BI - LESI Adapter (KLESI-B)

The display in Example 1 shows the KDB50 adapter (see ③) with an incorrect nexus value of 162. The correct nexus value of 161 (see ③) is displayed in Example 2.

Example 2: SYSGEN Command SHOW/CONFIGURATION

```
SYSGEN> SHOW /CONFIGURATION
System CSR and Vectors on 14-NOV-1991 12:04:09.78
Name: PUB Units: 1 Nexus:161 (KDB) ③
Name: EXA Units: 1 Nexus:48 (GXM)
Name: PUA Units: 1 Nexus:96 (KDM)
Name: TXA Units: 16 Nexus:165 (DMB)
Name: TXB Units: 8 Nexus:177 (DMB)
Name: PAA Units: 1 Nexus:181 (CI )
Name: ETA Units: 1 Nexus:216 (BVP)
Name: TXC Units: 8 Nexus:217 (DMB)
Name: PBC Units: 1 Nexus:220 (BVP)
Name: PTD Units: 1 Nexus:227 (UBA) CSR: 774500 Vector1: 000 Vector2: 000
SYSGEN> EXIT
```

System Services Reference Manual Correction

The QUI\$_AFTER_TIME Item Code in the \$GETQUI system service is documented incorrectly.

The documentation states that when you specify QUI\$_AFTER_TIME, \$GETQUI returns, as a quad-word absolute time value, the time at or after which the job can execute.

This is true if the job is submitted prior to the time at which it is to execute. However, if the time specified at submission has passed, the job executes immediately and \$GETQUI returns the system time at which the job was submitted.

VAX 6000-6xx System Booting Problem

Setting the SYSGEN parameter BUGREBOOT to 1 should initiate an automatic rebooting of VAX systems following a crash or controlled system shutdown. This behavior is correct on VAX 6000-610 uniprocessor systems. However, in multiprocessor VAX 6000-6xx configurations, when BUGREBOOT is set to 1, VMS occasionally prompts for the system date and time following a crash or system shutdown. In this situation, the following prompt appears on the system console during the system reboot:

```
PLEASE ENTER DATE AND TIME (DD-MMM-YYYY HH:MM)
```

To continue rebooting the system, enter the date and time as requested.

VAX 6000-600 Warm Start Problem for Systems with a Battery Backup Unit

If your VAX 6000-600 system contains a battery backup unit and recovers successfully from a power failure, the system will HALT at the next occurrence of any system error, whether or not the error is potentially recoverable. This HALT also prevents proper bugcheck crashes resulting from nonrecoverable hardware-related errors.

A patch is available to fix this problem. If a battery backup unit is installed in your VAX 6000-600 system, please contact your Customer Support Center for a copy of the patch.

VAX 62xx and 63xx Systems with KLESI or UNIBUS Adaptors

In VMS Version 5.5, the primary CPU backup cache on 62xx and 63xx systems with KLESI or UNIBUS adaptors is disabled. Having this cache disabled results in a 50 percent reduction in performance. A patch has been created to fix this problem. If you have systems with this configuration, please contact the Customer Support Center to obtain a copy of the patch.

X Terminal Support

Digital strongly recommends that you reboot all X terminals on your LAN after installing VMS Version 5.5.

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Cover Letter for VMS™ VAXcluster Software Version 5.5

AV-LS20F-TE

VMS VAXcluster systems are fully integrated with VMS Version 5.5 software and do not require a separate media and documentation kit.¹ Therefore, all orders that include the VMS Version 5.5 media and documentation kit also include VAXcluster images and documentation.

With the purchase of a VMS VAXcluster license, you will receive a VAXcluster Product Authorization Key (PAK). A VAXcluster license grants you the right to use the product as specified in the VAXcluster Software Product Description (SPD 29.78.05). You can register your VAXcluster PAK using the VMS License Management Facility. See the *VMS License Management Utility Manual* for more information.

VAXcluster Configurations

VMS Version 5.5 includes new information on support for multiple LAN adapters including a Fiber Distributed Data Interface (FDDI) adapter and new Digital Storage Systems Interconnect (DSSI) VAXcluster configurations. When configuring VAXcluster systems, you must adhere to the rules and recommendations described in the VAXcluster SPD.

VMS Version 5.4-3 to 5.5 Rolling Upgrade Restriction

If your configuration contains at least two computer systems with CIXCDs that boot from different system disks, and you plan to keep at least one of those systems at VMS Version 5.4-3, you must install a patch to all the VMS Version 5.4-3 system disks before you begin the rolling upgrade to VMS Version 5.5. See Section 7.2 in the *VMS Upgrade and Installation Manual* for more information on installing the patch. This patch does not apply if you are performing a rolling upgrade from a version of the VMS operating system prior to Version 5.4-3.

Mixed Version Clusters

Before installing VMS Version 5.5 on mixed version clusters, check the value for SCSMAXMSG on each node in the cluster. The value of SCSMAXMSG should be 132. If a node has a value of less than 132, increase the value to 132 using SYSGEN and reboot that node. Failure to do so will cause either the nodes running VMS Version 5.5 to exit with a CLUEXIT bugcheck, or the nodes with a value less than 132 to exit with a CLUEXIT bugcheck.

VAX 4000-500 Satellite Booting

In a VAXcluster configuration, the VAX 4000-500 can only boot as a satellite when booting from an integrated Ethernet adapter (EZA0). Booting from a Q-bus to Ethernet adapter (a DELQA) will be supported with a future maintenance release of the VMS operating system. Customers who require this support immediately can obtain a new NISCS_LOAD.EXE image from the Customer Support Center.

¹ The following are trademarks of Digital Equipment Corporation: CI, DEQNA, Digital, DSSI, Q-bus, VAX, VAXcluster, VMS, and the DIGITAL logo.

DEQNA Support

As of VMS Version 5.4-3, VAXcluster software did not support the DEQNA Q-bus to Ethernet adapter. If a node in your VAXcluster configuration is connected through a DEQNA device, you must replace the DEQNA with a DELQA or a DESQA before updating to VMS Version 5.4-3 or upgrading to VMS Version 5.5. Contact your Digital representative for information about the DEQNA upgrade program.

VMS Version 5.5 withdraws support for the DEQNA device, except for access using the QIO or ALTSTART interfaces. Within 18 months a release of the VMS operating system will withdraw all support for the DEQNA. After you install that future release, the Ethernet driver will place the DEQNA device in an OFFLINE state, rendering it inoperative.

To determine if your system has a DEQNA device installed, use the System Dump Analyzer (SDA) command SHOW DEVICE. The SHOW DEVICE command produces several displays that describe the devices in the system configuration. If your system has a DEQNA installed, it will be listed at the top of the first screen. For example:

```
S ANALYZE/SYSTEM
SDA> SHOW DEVICE XQA0

I/O data structures
-----
XQA0                               DEQNA      UCB address: 807084D0
Device status: 00002010 online,template
Characteristics: 0C042000 net,avl,idv,odv
                  00000000
Owner UIC [000000,000000] Operation count    0   ORB address 80708730
PID        00000000   Error count          0   DDB address 8091F680
Class/Type      20/21 Reference count       0   DDT address 80700074
Def. buf. size    512    BOFF             0140  CRB address 808D9D30
DEVDEPEND     00000000 Byte count           003C  I/O wait queue empty
DEVDEPND2     00000000 SVPATE            80FF09E0
FLCK index      34    DEVSTS            0000
DLCK address    8091F5A0
Charge PID      00000000
*** I/O request queue is empty ***
```

If your system has two Ethernet controllers, use the SDA command SHOW DEVICE XQA0 to check the first Ethernet for a DEQNA device. Then use SHOW DEVICE XQB0 to check the second Ethernet.

Cover Letter for InfoServer 150 System and VMS™ Version 5.5
AV-PFMAB-TE

Cost-Effective Software Loading and Distribution

Digital is pleased to introduce VMS Version 5.5 and the InfoServer 150 system.¹ This release features the expansion of the InfoServer initial system load (ISL) function from VAX 6000-only systems to other VAX systems, ranging from MicroVAX II through VAX 9000. System managers can load VMS Version 5.5 compact disc distribution onto system disks from one high-performance central network device. Customers benefit by sharing this cost-effective resource to load software.

In addition, system managers can install VMS operating system updates and layered product software using the InfoServer system, whether the software is distributed on tape or compact disc media. InfoServer Software Version 2.0 provides for the use of tape drives to benefit customers who use tapes.

Customers can also subscribe to Consolidated Software Distribution (CONDIST) to receive Digital's software products on compact disc. By purchasing a single set of compact discs, customers can save space and money. There is no longer a need to purchase separate tapes for each software product. Documentation for the VMS operating system and layered products is also available on compact disc in the Online Documentation Library (OLD) and can be accessed from InfoServer systems by using the VMS DECwindows Bookreader.

InfoServer support has been integrated into the VMS operating system since Version 5.4. All VAX systems running the VMS operating system can access storage from InfoServer systems. A VMS client kit is available for customers running VMS Versions 5.0 through 5.3, inclusive.

VMS Version 5.5 Initial System Load Support

ISL support is available for the following systems:

- VAX 9000, VAX 6000, VAX 4000, and VAXft systems
- MicroVAX systems
- VAXstation systems

This support allows initial system load and software installation on these processors using the VMS Version 5.5 compact disc located on an InfoServer compact disc drive. Software on these processors can also be upgraded using the VMS Version 5.5 compact disc located on an InfoServer compact disc drive.

InfoServer Software Version 2.0

New features for InfoServer Software Version 2.0 and enhancements to previous versions include the following:

- Magnetic tape support
 - TLZ04, TK50Z, TZ85, TZK10 SCSI tape drives
 - VMS tape client (VMS Backup and all other VMS utilities can use InfoServer tape drives.)

¹ The following are trademarks of Digital Equipment Corporation: Bookreader, DEC, DECwindows, MicroVAX, VAX, VAXft, VMS, and the DIGITAL logo.

- X Terminal support
- Improved information displays
- Installation of functional upgrades from compact discs
- Removal of client license restriction

InfoServer Software Version 2.0 runs on both the InfoServer 100 and InfoServer 150 systems.

InfoServer 150 System Components

The InfoServer 150 system includes the following components:

- One internal RRD42 compact disc drive
- One internal RZ23L hard disk drive
- Two external SCSI ports (to connect up to 12 external SCSI devices)

InfoServer 150 Package Systems

The following InfoServer 150 Package Systems are available:

- InfoServer 150 Model SEACD-AA includes InfoServer Software with Disk Function Access and one internal RRD42 compact disc drive.
- InfoServer 150 Model SEACE-AA includes InfoServer Software with Disk Function Access and one internal and one external RRD42 compact disc drive.
- InfoServer 150 Model SEACT-AA includes InfoServer Software with Disk and Tape Function Access and one internal RRD42 compact disc drive.
- InfoServer 150 Model SEACU-AA includes InfoServer Software with Disk Function and Tape Function Access and one internal and one external RRD42 compact disc drive.

Available Upgrades

The following optional upgrades are available for InfoServer systems:

- InfoServer Software Version 1.n to InfoServer Software Version 2.0 Upgrade license (QL-YSH99-RA)
- InfoServer Software Version 1.n to InfoServer Software Version 2.0 Upgrade media kit (QA-YSHAA-H8)
- InfoServer Tape Function Access upgrade license (QL-XZZA9-AA)
- InfoServer Tape Function Access upgrade media kit (QA-XZZAA-H8)

Note that Tape Function Access requires InfoServer Software Version 2.0.

For more information on the InfoServer 150 system, please contact your Digital sales representative.



